Digital Adaptation Kit
for Antenatal Care

Operational requirements for implementing WHO recommendations in digital systems

World Health Organization

human reproduction programme **hrp**

research for impact

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SMART GUIDELINES

Digital Adaptation Kit for Antenatal Care

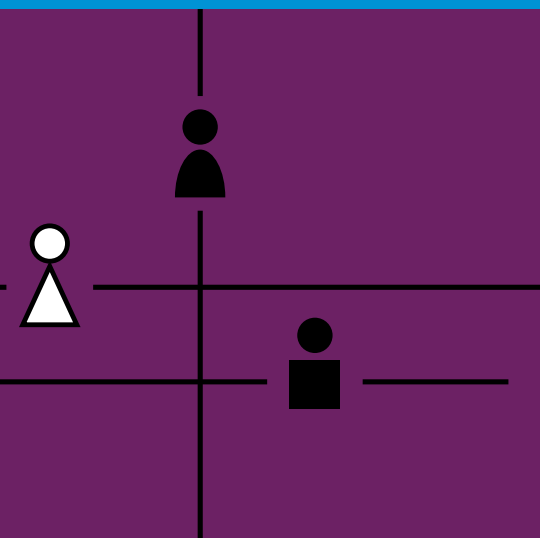**Operational requirements for implementing WHO recommendations in digital systems**

World Health Organization

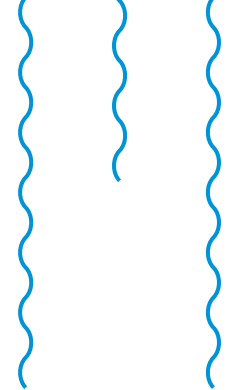human reproduction programme hrp

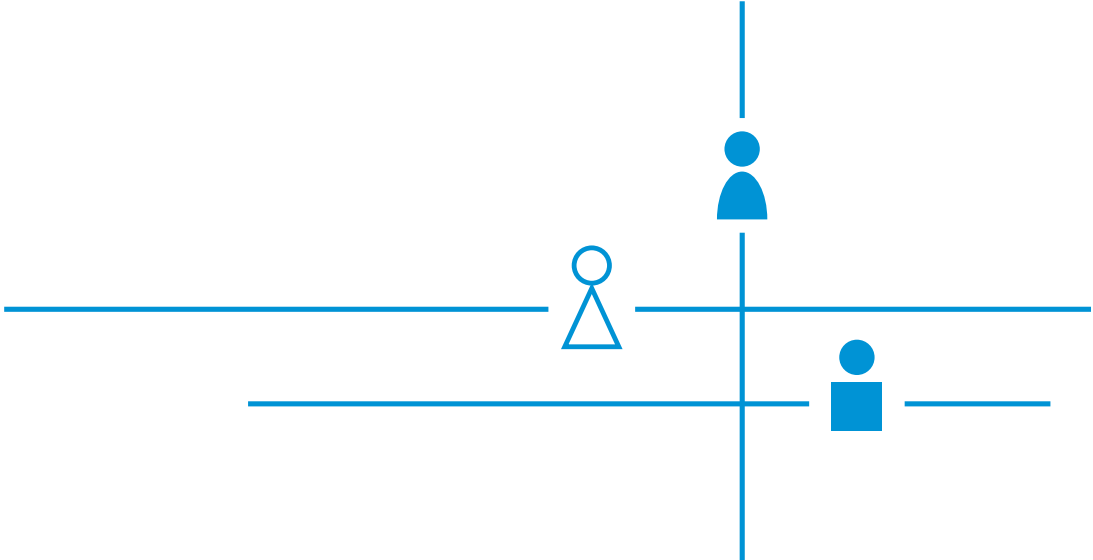research for impact

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SMART GUIDELINES

Digital adaptation kit for antenatal care: operational requirements for implementing WHO recommendations in digital systems

Contents

Part 1. Overview

Part 2. Digital adaptation kit content for antenatal care

Annexes

Web Annexes

Acknowledgements

World Health Organization

Abbreviations

ANC	antenatal care
ANM	auxiliary nurse midwife
API	application programming interface
ASB	asymptomatic bacteriuria
BMI	body mass index
BPMN	business process model and notation
CDC	Centers for Disease Control and Prevention
CDS	clinical decision support
CQL	clinical quality language
CHW	community health worker
DAK	digital adaptation kit
DBP	diastolic blood pressure
DE	data element
DHI	Digital Health and Innovations (WHO Department)
DHIS2	District Health Information Systems (version 2)
DIIG	Digital investment implementation guide
DM	diabetes mellitus
DMN	Decision Model Notation
DT	decision-support table
DTDS	digital tracking and decision support
eHealth	electronic health
EDD	estimated due date
EMR	electronic medical record
FHIR	Fast Health Interoperability Resources
GA	gestational age
GDM	gestational diabetes mellitus
HEADSS	home, education, activities/employment, drugs, suicidality and sex
HL7	Health level 7, Inc.
HIS	health information system
HMIS	health management information system
HPV	Human papillomavirus
ICD	International Classification of Diseases
ICF	International Classification of Functioning, Disability and Health
ICHI	International Classification of Health Interventions
ICT	information and communications technology
ID	identification
IFA	iron and folic acid
IHE	Integrating the Healthcare Enterprise
IPTp	intermittent preventive treatment in pregnancy
IPV	intimate partner violence
ISCO	International Standard for Classification of Occupations
ITU	International Telecommunication Union
LMP	last menstrual period
LOINC	Logical Observation Identifiers Names and Codes
M&E	monitoring and evaluation
MAPS	mHealth Assessment and Planning for Scale
NFXNREQ	non-functional requirement
mHealth	Mobile Health
MOH	ministry of health

OHCHR	Office of the High Commissioner for Human Rights
OpenHIE	Open source Health Information Exchange
PICT	provider-initiated counselling and testing
PNC	postnatal care
PrEP	pre-exposure prophylaxis
QR	Quick Response (i.e. QR code)
RAM	rapid assessment and management
SRH	Sexual and Reproductive Health and Research (WHO department)
SRHR	sexual and reproductive health and rights
SBP	systolic blood pressure
SFH	symphysis fundal height
STI	sexually transmitted infection
SMS	short message service (text message)
SNOMED	Systematized Nomenclature of Medicine
SOP	standard operating procedure
SP	sulfadoxine–pyrimethamine
TB	tuberculosis
TTCV	tetanus toxoid-containing vaccine
UHC	universal health coverage
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNFPA	United Nations Population Fund
WHO	World Health Organization

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Part

1

Overview
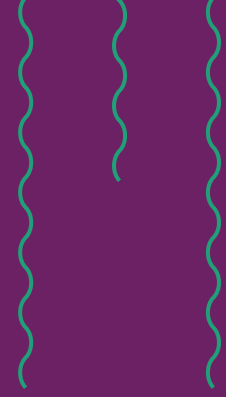
Background

Digital health – defined broadly as 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)* – is increasingly being applied as an essential enabler for health service delivery and accountability. Ministries of health have recognized the value of digital health as articulated within the World Health Assembly resolution *(2)* and the *Global strategy on digital health (3)*. Likewise, donors have advocated for the rational use of digital tools as part of efforts to expand coverage and quality of services, as well as promote data use and monitoring efforts *(4–6)*. Despite the investments into and abundance of digital systems, there is often limited understanding of and transparency in the health data and logic contained in these digital tools, or relationship with evidence-based clinical or public health recommendations, which not only undermines the credibility of such systems, but also impedes opportunities for interoperability and threatens potential for continuity of care.

Evidence-based recommendations, such as those featured in WHO guidelines, establish standards of care and offer a reference point for informing the content of digital systems that countries adopt. However, guidelines are often only available in a narrative format that requires a resource-intensive process to be elaborated into the specifications needed for digital systems. This translation of guidelines for digital systems often results in subjective interpretation for implementers and software vendors, which can lead to inconsistencies or inability to verify the content within these systems, potentially leading to adverse health outcomes and other unintended effects. Additionally, where digital systems exist, the documentation of the underlying data and content may be unavailable or proprietary, requiring governments to start from scratch and expend additional resources each time they intend to deploy such a system. Furthermore, this lack of documentation of the health content can lead to dependence on one vendor and haphazard deployments that are unscalable or difficult to replicate across different settings.

To ensure countries can effectively benefit from digital health investments, "digital adaptation kits" (DAKs) are designed to facilitate the accurate reflection of WHO's clinical, public health and data use guidelines within the digital systems countries are adopting. DAKs are operational, software-neutral, standardized documentation that distil clinical, public health and data use guidance into a format that can be transparently incorporated into digital systems. Although digital implementations comprise multiple factors – including (i) the health domain data and content; (ii) the digital intervention or functionality; and (iii) the digital application or communication channel for delivering the digital intervention – DAKs focus primarily on ensuring the validity of the health content (see *Figure 1*) *(7)*. Accordingly, DAKs provide the generic content requirements that should be housed within digital systems, independently of a specific software application and with the intention that countries can customize them to local needs.

Digital Adaptation Kit for Antenatal Care

World Health Organization

For this particular DAK, the requirements are based on systems that provide the functionalities of digital tracking and decision support (see *Box 1*) and include components such as personas, workflows, core data elements, decision-support algorithms, scheduling logic and reporting indicators. Operational outputs, such as spreadsheets of the data dictionary and the detailed decision-support algorithms, are included as part of the DAK as practical resources that implementers can use as starting points when developing digital systems. Furthermore, data components within the DAK are mapped to standards-based terminology, such as the International Classification of Diseases (ICD), to facilitate interoperability.

The DAKs follow a modular approach in detailing the data and content requirements for a specific health programme area – such as antenatal care, family planning, sexually transmitted infections (STIs) – among the different health areas for which DAKs have been developed. This specific DAK focuses on providing the content requirements for a digital tracking and decision-support system used by health workers during antenatal care (ANC) and is based on the WHO ANC guideline: *WHO recommendations on antenatal care for a positive pregnancy experience (8)*. It also includes cross-cutting elements focused on the client, such as self-care interventions, though these interventions are described from the perspective of the health worker, not from that of the clients.

FIG. 1

Digital adaptation kits and their role in digital health implementations

HEALTH CONTENT
Information that is aligned with recommended health practices or validated health content

+

DIGITAL HEALTH INTERVENTIONS
A discrete function of digital technology to achieve health-sector objectives

+

DIGITAL APPLICATIONS
ICT systems and communication channels that facilitate delivery of the digital interventions and health content
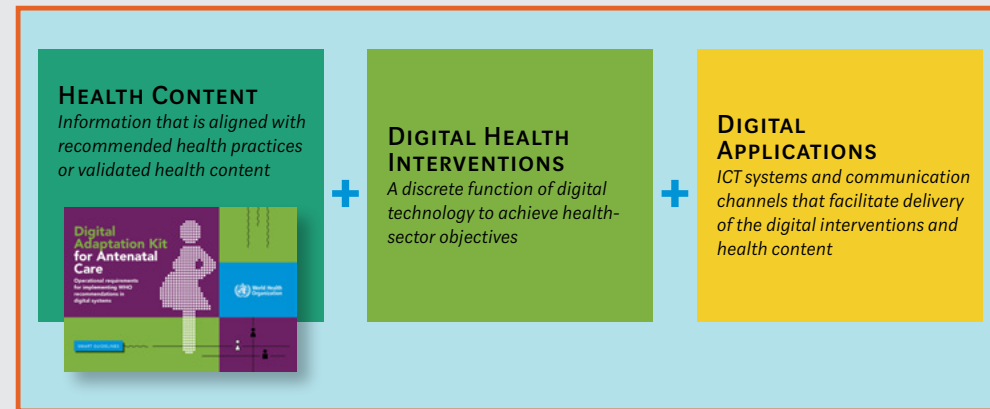
FOUNDATIONAL LAYER: *ICT and enabling environment*

LEADERSHIP & GOVERNANCE

STRATEGY & INVESTMENT

SERVICES & APPLICATIONS

STANDARDS & INTEROPERABILITY

INFRASTRUCTURE

LEGISLATION, POLICY & COMPLIANCE

WORKFORCE

BOX 1
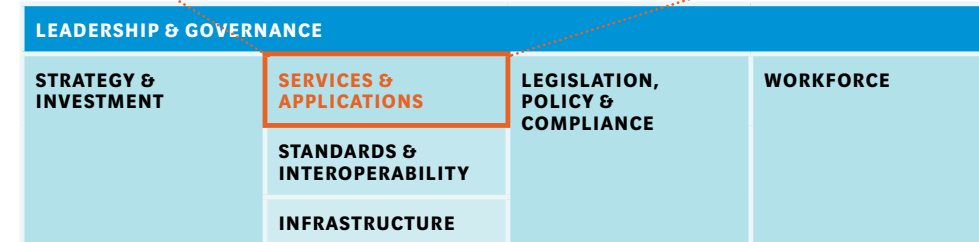
What is digital tracking and decision support?

Digital tracking is the use of digitized records to capture and store clients' health information to enable follow-up of their health status and services received. This may include digital forms of paper-based registers and case management logs within specific target populations, as well as electronic patient records linked to uniquely identified individuals *(7,9)*.

Digital tracking makes it possible to register and follow up patient services, and may be done through an electronic medical record (EMR) or other digital forms of health records. Digital tracking aims to reduce lapses in continuity of care by stimulating timely follow-up contacts, and may incorporate decision-support tools to guide health workers in: executing clinical protocols to deliver appropriate care, scheduling upcoming services and following checklists for appropriate case management at point of care. Some other descriptors include "digital versions of paper-based registers for specific health domains; digitized registers for longitudinal health programmes including tracking of migrant populations' benefits and health status; case management logs within specific target populations, including migrant populations" *(9)*.

Health worker decision support is defined as: "digitized job aids that combine an individual's health information with the health worker's knowledge and clinical protocols to assist health workers in making diagnosis and treatment decisions" *(9)*. Thus, a person-centred digital tracking and decision-support (DTDS) system is one used by health workers at the point of care; it includes a persistent record of health events and encounters that links to clinical decision-support systems to reinforce good practice. It also links to reporting and management tools to reinforce accountability. A DTDS record includes all the information required for detailing an individual's health status and the health interventions provided to them.

DTDS end-users are all cadres of health-care providers operating at all care levels, including those operating outside of formal health-care facilities (e.g. community health workers, health volunteers). DTDS systems emphasize the use of "collect once, use for many purposes" *(10)*, in which data collected for service delivery can also be used for accountability (i.e. they can be used to calculate aggregate indicators required for reporting, including monitoring provider, stock and system performance).

WHO has provided the following context-specific recommendation for the use of an integrated system that provides both a digital track of client's health status and decision support *(7)*.
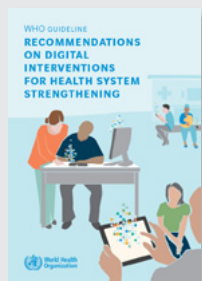
| **Effective coverage** **Accountability coverage** | Digital tracking of clients' health status and services (digital tracking) combined with decision support | **RECOMMENDATION 8:** WHO recommends digital tracking of clients' health status and services, combined with decision support under these conditions: ‣ in settings where the health system can support the implementation of these intervention components in an integrated manner; and ‣ for tasks that are already defined as within the scope of practice for the health worker. *(Recommended only in specific contexts or conditions)* |

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Digital adaptation kits within a strategic vision for SMART Guidelines

The operational and standardized documentation reflected within the DAKs represent one of the steps within a broader vision of **S**tandards-based, **M**achine-readable, **A**daptive, **R**equirements-based, and **T**estable (SMART) Guidelines. SMART Guidelines aim to maximize health impact through improved fidelity and uptake of recommendations through a systematic process for transforming guideline development, delivery and application *(11,12)*. Within this vision, DAKs serve as a prerequisite for developing computable, or machine-readable, guidelines, as well as executable reference software and advanced analytics for precsion health. Figure 2 provides an overview of the different layers of the SMART Guidelines continuum and where DAKs fit within this strategy *(11)*.

FIG. 2

Progressive layers across SMART Guideline components

Paper systems ↓ Smart digital systems			
L1 Narrative	**Narrative guidelines**	Evidence-based guideline recommendations and accompanying implementation and data guidance
L2 Operational	**Digital adaptation kits**	"Human readable" software-neutral documentation of operational and functional requirements (e.g. personas, workflows, relevant metadata, transparently documented algorithms, minimum data sets, priority metrics, listing of relevant health interventions, functional requirements)
L3 Machine readable	**Machine readable recommendations**	Structured software-neutral specifications, code, terminology and interoperability standards
L4 Executable	**Reference software**	Software that are able to execute executable static algorithms and interoperable digital components to deliver the operational and functional requirements
L5 Dynamic	**Precision health model**	Executable dynamic algorithms that are trained and optimized with advanced analytics to achieve prioritized outcomes

Objectives

This DAK focuses on antenatal care (ANC) and aims to provide a common language across various audiences – maternal health and other programme managers, software developers, and implementers of digital systems – to ensure a common understanding of the appropriate health information content within the ANC health programme area, as a mechanism to catalyse the effective use of these digital systems. The key objectives of this DAK are:

»   to ensure adherence to WHO clinical, public health and data use guidelines, and facilitate consistency of the health content that is used to inform the development of a person-centred digital tracking and decision-support (DTDS) system;

»   to enable health programme leads and digital health teams (including software developers) to have a joint understanding of the health content within the digital system, through a transparent mechanism to review the validity and accuracy of the health content; and

»   to provide a starting point of the core data elements and decision-support logic that should be included within DTDS systems for ANC.

Information detailed in this DAK reflects generic workflow processes, data and decision-support algorithms, as derived from the 2016 *WHO recommendations on antenatal care for a positive pregnancy experience (12)* and other related WHO documents described below. This DAK also includes technical considerations for self-care interventions from the perspective of the health worker who promotes these interventions to a client. In addition, this DAK describes linkages to related services for ANC, such as the identification and management of intimate partner violence (IPV) and considerations for adolescents. **Note that the outputs of the DAKs are intentionally generic and will need to be contextualized to local policies and requirements.**
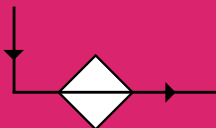
DAKs have also been developed for family planning, HIV and STIs, and this approach is being expanded to additional health domains, such as immunizations, postnatal care (PNC), and child health. To complement these there is a forthcoming DAK for self-care interventions from the perspective of a client; taken together, all of these DAKs work towards a comprehensive approach for standardized software requirements for primary health care settings.

Digital Adaptation Kit for Antenatal Care

World Health Organization

Components of a digital adaptation kit
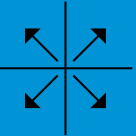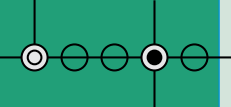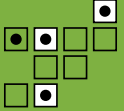
The DAK comprises eight interlinked components: (1) health interventions and associated recommendations; (2) generic personas; (3) user scenarios; (4) generic business processes and workflows; (5) core data elements; (6) decision-support logic; (7) indicators and reporting requirements; and (8) high-level functional and non-functional requirements. Table 1 provides an overview of each of the contributing components of the DAK, which this document elaborates. All information within the adaptation kit represents a generic starting point, which can then be adapted according to the specific context. Furthermore, this DAK builds on previous requirements, gathering work conducted by PATH in *Common requirements for maternal health information systems (13)* by leveraging the developed workflows and elaborating on the data and decision-support requirements.

Table 1. Components of a digital adaptation kit

Component	Description	Purpose	Outputs	Adaptation needed
1. Health interventions and recommendations	Overview of the health interventions and WHO recommendations included within this digital adaptation kit (DAK). DAKs are meant to be a repackaging and integration of WHO guidelines and guidance documents in a particular health domain. The list of health interventions is drawn from the universal health coverage (UHC) menu of interventions compiled by WHO *(14)*.	**Setting the stage** – To understand how this DAK would be applied to a digital tracking and decision-support system in the context of specific health programmes and interventions	» **List of related health interventions** based on WHO's UHC essential interventions » **List of related WHO recommendations** based on guidelines and guidance documents	» Contextualization to reflect current or planned national policies
2. Generic personas	Depiction of the end-users, supervisors and related stakeholders who would be interacting with the digital system or involved in the care pathway. A local adaptation of the personas should contain high-level information to describe the provider of the health service (e.g. the general background, roles and responsibilities, motivations, challenges, and environmental factors).	**Contextualization** – To understand the wants, needs and constraints of the end-users	» Description, competencies and essential interventions performed by targeted personas	» Greater specification and details on the end-users based on real people (i.e. health workers) in a given context

Component	Description	Purpose	Outputs	Adaptation needed
3. User scenarios	Narratives that describe how the different personas may interact with each other. The user scenarios are only illustrative and intended to give an idea of a typical workflow.	**Contextualization** – To understand how the system would be used, and how it would fit into existing workflows	» Example **narrative** of how the targeted personas may interact with each other during a workflow	» Greater specification and details on the real needs of end-users in a given context
4. Generic business processes and workflows	A business process is a set of related activities or tasks performed together to achieve the objectives of the health programme area, such as registration, counselling, referrals *(1,15)*. Workflows are a visual representation of the progression of activities (tasks, decision points, interactions) that are performed within the business process *(1,16)*.	**Contextualization** and system design – To understand how the digital system would fit into existing workflows and how best to design the system for that purpose	» Overview matrix presenting the **key processes** in antenatal care (ANC) » **Workflows** for identified business processes with annotations	» Customization of the workflows that can include additional forks, alternative pathways or entirely new workflows
5. Core data elements	Data elements required throughout the different points of the workflow. These data elements are mapped to the International Classification of Diseases version 11 (ICD-11) codes and other established concept mapping standards to ensure the data dictionary is compatible with other digital systems.	**System design and interoperability** – To know which data elements need to be logged and how they map to other standard terminologies (e.g. ICD, Systematized Nomenclature of Medicine [SNOMED]) for interoperability with other standards-based systems	» List of data elements » Link to **data dictionary** with detailed data specifications in spreadsheet format (see *Web Annex A*).	» Translation of "data labels" into the local language and additional data elements created depending on the context

Digital Adaptation Kit for Antenatal Care

World Health Organization

Component		Description	Purpose	Outputs	Adaptation needed
6. Decision-support logic		Decision-support logic and algorithms to support appropriate service delivery in accordance with WHO clinical, public health and data use guidelines.	**System design and adherence to recommended clinical practice** – To know what underlying logic needs to be coded into the system	» List of decisions that need to be made throughout the encounter » **Link to decision-support tables** in a spreadsheet format with inputs, outputs and triggers for each decision-support logic (see *Web Annex B*) » Scheduling logic for services	» Change of specific thresholds or triggers in a logic (IF/THEN) statement, e.g. body mass index (BMI) cut-off, age trigger for "youth friendly" services » Additional decision-support logic formulas depending on the context
7. Indicators and performance metrics		Core set of indicators that need to be aggregated for decision-making, performance metrics, and subnational and national reporting. These indicators and metrics are based on data that can feasibly be captured from a routine digital system, rather than survey-based tools.	**System design and adherence to recommended health monitoring practices** – To know what calculations and secondary data use is needed for the system, based on the principle of "collect once, use many" *(10)*	» **Indicators table** with numerator and denominator of data elements for calculation, along with appropriate disaggregation (See *Web Annex C*)	» Changing calculation formulas of indicators » Adding indicators » Changing the definition of the primary data elements used to calculate the indicator based on data available
8. Functional and non-functional requirements		List of core functions and capabilities the system must have to meet the end-users' needs and achieve tasks within the business process.	**System design** – To know what the system should be able to do	» **Table of functional and non-functional requirements** with the intended end-user of each requirement, as well as why that user needs that functionality in the system (See *Web Annex D*)	» Adding or reducing functions and system capabilities based on budget and end-user needs and preferences

BOX 2

Notation guidance

Throughout the DAK, there are identification (ID) numbers to simplify tracking and referencing of each of the components. Note that the DAK represents an overview across the different components, while the comprehensive and complete outputs of each component (e.g. data dictionary, decision-support tables) are included in appended spreadsheets. The notation guidance is as follows.

Component 1: Health interventions and recommendations
No notations used

Component 2: Generic personas
No notations used

Component 3: User scenarios
No notations used

Component 4: Business processes and workflows
Each workflow should have a "Process name" and a corresponding letter

» Each workflow should also have a "Process ID" that should be structured "Abbreviated health domain" (e.g. ANC). "Corresponding letter for the process" (e.g. A)

» Each activity in the workflow should be numbered with an "Activity ID" that should be structured "Process ID" from above "Activity Number" e.g. ANC.B7

Component 5: Core data elements (data dictionary)
Each data element should have a running number and a "Data Element (DE) ID" that should be structured "Abbreviated health domain" (e.g. ANC). "DE". "Sequential number of the data element" (e.g. ANC.B7.DE.1, ANC.B7.DE.2)

Component 6: Decision-support logic
Each decision-support logic table should have a running number and a "Decision-support table (DT) ID" that should be structured "Abbreviated health domain" (e.g. ANC). "DT". "Sequential number of the decision-support table" (e.g. ANC.DT.1, ANC.DT.2)

Component 7: Indicators and performance metrics
Each indicator should have an "Indicator ID" that should be structured "Abbreviated health domain" (e.g. ANC). "IND". "Sequential number of the indicator" (e.g. ANC.IND.1, ANC.IND.2)

Component 8: High-level system requirements
» Each functional requirement should have a "Functional requirement ID" that should be structured "Abbreviated health domain" (e.g. ANC). "REQ". "Sequential number of the functional requirement" (e.g. ANC.REQ.1, ANC.REQ.1)

» Each non-functional requirement should have a "Non-functional requirement ID" that should be structured "Abbreviated health domain" (e.g. ANC). "NFXNREQ". "Sequential number of non-functional requirements" (e.g ANC.NFXNREQ.1, ANC. NFXNREQ.2)

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How to use this digital adaptation kit

Target audience

The primary target audience for this DAK is health programme managers within the ministry of health (MOH), who will be working with their digital or health information systems counterparts in determining the health content requirements for an ANC DTDS system. The health programme manager is responsible for overseeing and monitoring the implementation of the clinical practices and policies for the health programme area, in this case ANC.

The DAK also equips individuals responsible for translating health-system processes and guidance documents for use within digital systems with the necessary components to kick-start the process of developing a DTDS system in a standards-compliant manner. These individuals are also known as business analysts who interface between health content experts and software development teams. Specifically, the adaptation kit contains key outputs, such as the data dictionary and decision-support algorithms, to ensure the validity and consistency of the health content with the DTDS system.

Additionally, using this DAK requires a collaboration between health programme managers and counterparts in digital health and health information systems. Although each DAK focuses on a particular health programme area (in this case ANC), the DAKs are envisioned to be used in a modular format and link to other health programme areas within primary health care settings, in an effort to support integration across services. For example, WHO will be releasing a DAK for family planning and is also planning the development of a PNC DAK to be released following the publication of the PNC guidelines, to ensure care across the sexual and reproductive health continuum, along with DAKs for other health areas.

Scenarios for using the DAK

The DAK may be used across various scenarios, some of which are listed below.

Scenario 1: **Incorporating WHO guideline content into existing digital tracking and decision-support systems**	Countries that already have digital systems in place, such as electronic medical records (EMRs) and decision-support tools, may use the information in the DAK to cross-check whether the underlying content and data for specific health programme areas, such as ANC or family planning, are aligned to WHO guidelines. Users of the DAK can identify and extract specific decision algorithms that would need to be incorporated into their existing digital systems. By reviewing this systematic documentation, health programme managers and implementers can more readily identify differences in workflows, data inputs and decision-support logics to examine the rationale for deviations and understanding local adaptions of guideline content.

Scenario 2: **Transitioning from paper to digital tracking and decision-support systems**	Some countries may currently have paper-based systems that they would like to digitize. The process of optimizing paper-based client-level systems into digital records and decision support may be overwhelming. Users in this scenario may review the DAK as a starting point for streamlining the necessary data elements and decision support that should be in the optimized client-level digital system. Users may also then refer to the paper-based tools to determine whether there are missing fields or content that should also be included in the digital system. Additionally, users should also review the WHO *Handbook for digitizing primary health care (17)*, which provides stepwise guidance on how to map data on paper-based forms into a digital system, including ways of accounting for data elements that are redundant or may not add value to the health system.
Scenario 3: **Linking aggregate HMIS (e.g. DHIS2) to digital tracking and decision-support systems used at point of care**	In some instances, countries may already have a digital system for aggregate reporting and HMIS, but may not yet have implemented digital systems that function at the service-delivery level. The DAK can guide the development of a digital client record system that operates at point of care, and ensure that there are linkages between the aggregate and service-delivery levels (e.g. community or facility level). As such, a component of the DAK provides aggregate indicators derived from individual-level data to provide the linkage between these different levels. Complementary guidance dedicated specifically to aggregate-level data, such as *Analysis and use of facility: guidance for RMNCAH [reproductive, maternal, newborn, child and adolescent health] programme managers (18)*, should also be consulted for supporting the use of routine data at the facility management and district levels.
Scenario 4: **Leveraging data standards to promote interoperability and integrated systems**	This DAK includes data elements mapped to ICD codes, and other standards, to support the design of interoperable systems. The data dictionary in the *Web Annex A* provides the necessary codes for different data elements, thus reducing the time for implementers to incorporate these global standards into the design of their digital systems.

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Scenario 5: **Adapting the reference WHO ANC digital module**	WHO will be releasing a reference ANC digital module as a decision-support and digital tracking tool that reflects the ANC DAK content to assist countries in identifying which data elements and decision-support logic will need to be modified for their context. In addition, a critical part of service delivery in any health domain relies on engaging with clients, for example, pregnant women in the ANC domain. Digital interventions aimed at clients themselves, inclusive of pregnant women, such as on-demand information services, targeted client communication (e.g. transmitting health information and reminders), reporting of health-system feedback by clients on the quality of care, accessing their own medical records/home-based records, and self-monitoring of their health and diagnostic data *(8)*, are all emerging approaches for complementing the services provided by health workers. The content requirements for these client-facing digital tools will be detailed in a forthcoming self-care interventions DAK.

Assumptions

The use of this DAK for ANC is also based on the following critical assumptions.

» The woman's pregnancy is confirmed, and she intends to proceed with the pregnancy.

» ANC contact is being provided in the context of routine services at the primary care level.

» Content for the ANC contact is intended for routine services in primary health care (i.e. not for specialized services).

» Local adaptations will be made to this DAK, as this document is intended to reflect commonalities generalized from different settings (the content is assumed to be 80% generic for use across different settings and 20% of the content will require local contextualization).

» National policy makers for ANC plan to or have already adopted and adapted the WHO ANC guideline *WHO recommendations on antenatal care for a positive pregnancy experience* to the local context *(19)*. For countries that are yet to adopt and adapt the 2016 WHO ANC guideline, the contents of the DAK can support the transition to the recommended interventions by presenting them in a format that can be digitized.

For the purposes of this DAK, the terms "woman" and "client" will be used interchangeably to denote the individual seeking ANC services. The term "client" will be used for general processes, such as registration, that may apply for other health areas; the term "woman"or "pregnant woman" will be used in contexts of ANC-specific processes.

Linkages to the broader digital health ecosystem

DAKs represent one resource in the broader digital health ecosystem and should be used once there is a strategic vision by the MOH to use a DTDS system. In contexts where such a vision may not exist, users should first consult the WHO–ITU *National eHealth strategy toolkit (20)*, WHO guidelines on digital interventions for health system strengthening *(7)* and the WHO *Digital investments and implementation guide (1)* to establish a better understanding of how to select and apply appropriate digital health interventions. Fig. 3 situates DAKs within the broader set of resources for planning and implementing digital health systems.

FIG. 3

Digital adaptation kits within the broader digital health ecosystem

STEPS

PHASE		STEPS					
PHASE 01	**ASSESSING THE CURRENT STATE AND ENABLING ENVIRONMENT**	+ Conduct an inventory of existing or previously used software applications, ICT systems and other tools to better understand the requirements for reuse and interoperability	WHO–ITU National eHealth strategy toolkit		WHO Digital health atlas	Global digital health index	Digital health investment review tool	HIS Stages of continuous improvement
PHASE 02	**ESTABLISHING A SHARED UNDERSTANDING AND STRATEGIC PLANNING**	+ Develop a national digital health strategy outlining overarching needs, desired activities and outcomes + Define a vision for how the health system will be strengthened through the use of digital technology		Digital implementation investment guide	WHO Guideline: Recommendations on Digital Interventions for Health System Strengthening	WHO Classification of digital health interventions	Principles for donor alignment	Principles for digital development
PHASE 03	**DEFINING THE FUTURE STATE**	+ Formulate a digital health investment roadmap to support the national digital health strategy + Plan and identify appropriate digital interventions, alongside the health and data content, to improve health system processes and address programmatic needs			ITU SDG Digital investment framework (eGov)	ITU Digital health platform handbook	Digital Square Global goods guidebook	UNICEF Human-centred design toolkit / WHO Digital clearing-house
PHASE 04	**PLANNING THE ENTERPRISE ARCHITECTURE**	+ Review the current state and develop an architecture blueprint for the design of the digital health implementations + Identify validated open standards to ensure data exchange, systems integration and future-proofing of digital health implementations.	Open Health Information Exchange (Open HIE)				The Open Group Architecture Framework (TOGAF)	Guidance for investing in digital health / World Bank Digital identity toolkit
PHASE 05	**DETERMINING HEALTH CONTENT REQUIREMENTS**	+ Identify validated health content appropriate for the implementation context + Ensure use of content aligned with identified standards for the future state	WHO handbook for digitalizing primary health care		**WHO SMART GUIDELINES** Digital adaptation kits *(this document)*	Machine-readable recommendations	WHO Core indicator sets	Be He@lthy, Be Mobile handbooks for non-communicable diseases
PHASE 06	**M&E OF DIGITAL HEALTH IMPLEMENTATIONS AND FOSTERING DATA USE**	+ Monitor your implementation to ensure digital implementations are functioning as intended and having the desired effect + Foster data-driven adaptive change management within the overall health system	WHO Monitoring and evaluating digital health interventions	PATH Defining and building a data use culture	MEASURE data demand and use of resources			
PHASE 07	**IMPLEMENTING, MAINTAINING AND SCALING**	+ Maintain and sustain digital health implementations + Identify risks and appropriate mitigations	WHO MAPS toolkit: mHealth assessment and planning for scale	Asian Development Bank Total cost of ownership tool				

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ICT: information and communications technology; M&E: monitoring and evaluation.
Source: Adapted from WHO *(1)*.

Digital Adaptation Kit for Antenatal Care

World Health Organization

Part **2** **Digital adaptation kit content for antenatal care**

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

Component

1

Health interventions and recommendations

This **DAK focuses** on the following health interventions and recommendations.

1.1 Interventions referenced in this DAK are based on the WHO universal health coverage (UHC) list of interventions

The key interventions for routine antenatal care (ANC) are the following, as defined in the WHO UHC compendium of interventions *(14)*:

- » health education and counselling to promote healthy pregnancy
- » nutritional supplementation during pregnancy
- » maternal and fetal assessment and screening during pregnancy
- » preventive measures and vaccination during pregnancy
- » treatment for physiological symptoms during pregnancy
- » ANC models with a minimum of eight contacts.

1.2 WHO guidelines, recommendations and guidance

The DAKs are intended to reflect health recommendations and content that has already been published in WHO guidelines and guidance documents. The health content and interventions are drawn from the *WHO recommendations on antenatal care for a positive pregnancy experience (2016)* and additional guidance also available through the ANC portal (*www.srhr.org/antenatalcare/*).

Digital Adaptation Kit for Antenatal Care

World Health Organization
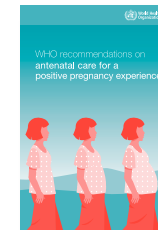
Other guidelines represented in the DAK include:

» *Systematic screening for active tuberculosis: principles and recommendations (2013)*

» *Diagnostic criteria and classification of hyperglycaemia first detected in pregnancy (2013)*

» *WHO recommendations on community mobilization through facilitated participatory learning and action cycles with women's groups for maternal and newborn health (2014)*

» *WHO recommendations for the prevention and management of tobacco use and second-hand smoke exposure in pregnancy (2013)*

» *Guidelines for the identification and management of substance use and substance use disorders in pregnancy (2014)*

» *Consolidated guidelines on HIV testing services. 5Cs: consent, confidentiality, counselling, correct results and connection (2015)*

» *Guidelines for the treatment of malaria (3rd edition, 2015)*

» *Guideline on when to start antiretroviral therapy and on pre-exposure prophylaxis for HIV (2015)*

» *WHO recommendations on health promotion interventions for maternal and newborn health 2015*

» *Consolidated guideline on sexual and reproductive health and rights of women living with HIV (WHO, UNAIDS, UNFPA, OHCHR, 2017)*

» *Guideline: preventive chemotherapy to control soil-transmitted helminth infections in at-risk population groups (2017)*

» *WHO guideline on syphilis screening and treatment for pregnant women (2017)*

» *Guidelines on hepatitis B and C testing (2017) WHO recommendations on adolescent sexual and reproductive health and rights (2018)*

» *WHO recommendations: intrapartum care for a positive childbirth experience (2018)*

» *WHO consolidated guideline on self-care interventions for health (2019)*

» *WHO recommendations for prevention and treatment of pre-eclampsia and eclampsia (2011); also updated in 2018 and 2020*

Implementation and data guidance that contributed to DAK components include:

» *WHO recommendations: optimizing health worker roles to improve access to key maternal and newborn health interventions through task shifting (2012)*

» *Responding to intimate partner violence and sexual violence against women: WHO clinical and policy guidelines (2013)*

» *Pregnancy, childbirth, postpartum and newborn care: a guide for essential practice (3rd edition, 2015)*

» *Managing complications in pregnancy and childbirth: a guide for midwives and doctors (2nd edition, 2017)*

» *WHO/UNICEF guidance note: ensuring sustained protection against diphtheria: replacing Tetanus Toxoid with Tetanus–diphtheria vaccine (2018)*

» *Analysis and use of health facility data: guidance for RMNCAH (2019)*

» *Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected (Interim guidance, 13 March 2020)*

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

RECOMMENDATIONS
PERSONAS
SCENARIOS
WORKFLOWS
DATA
DECISIONS
INDICATORS
REQUIREMENTS

Component **2** # Generic personas
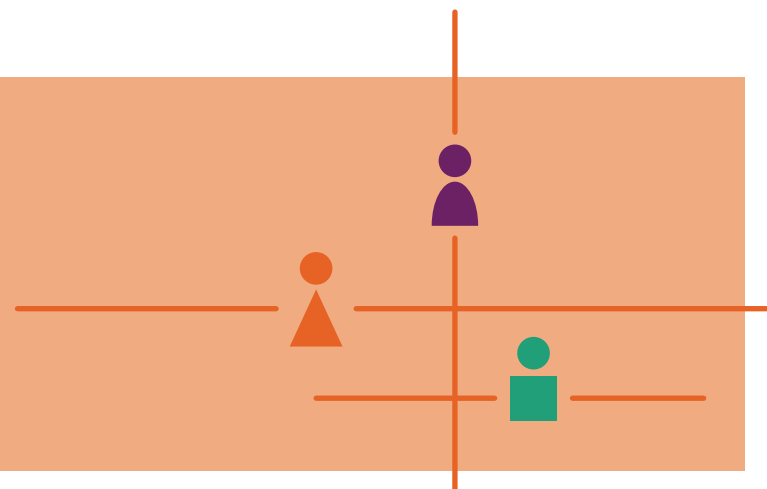
A **persona is** a depiction of a relevant stakeholder, or "end-user", of the system. Although the specific roles and demographic profile of the personas will vary depending on the setting, the generic personas are based on the WHO core competencies and credentials of different health worker personas. Please note that these are developed based on synthesis across multiple contexts as a starting point, and further contextualization will be required according to the needs, motivations and challenges of the targeted personas in each setting.

2.1 Targeted generic personas

The targeted personas for this ANC DAK are skilled health-care professionals operating in primary health care settings and able to provide the essential interventions listed below. WHO and others define skilled health personnel "as competent maternal and newborn health professionals educated, trained and regulated to national and international standards. They are competent to:

(i) provide and promote evidence-based, human-rights-based, quality, socio-culturally sensitive and dignified care to women and newborns;
(ii) facilitate physiological processes during labour and delivery to ensure a clean and positive childbirth experience; and
(iii) identify and manage or refer women and/or newborns with complications" *(21)*.

In the case of ANC, the occupational titles of the targeted personas include auxiliary nurse midwives (ANM), nurses and midwives, though other health-care professionals with competencies above this level may also be included. The descriptions of these targeted health worker personas as defined by the WHO are presented in *Table 2* *(23)*.

Digital Adaptation Kit for Antenatal Care

World Health Organization

Table 2. Descriptions of key generic personas

Occupational title	Description	Different Names	ISCO Code *(23)*
Auxiliary nurse midwife (ANM)	Auxiliary nurse midwives (ANMs) assist in the provision of maternal and newborn health care, particularly during childbirth but also in the prenatal and postpartum periods. ANMs have some training in secondary school and a period of on-the-job training may be included, sometimes formalized in apprenticeships. Like an auxiliary nurse, an auxiliary nurse midwife has basic nursing skills but no training in nursing decision-making. They possess some competencies in midwifery but are not fully qualified as midwives *(22)*.	Auxiliary midwife (e.g. *Bidan* in Indonesia)	3221 (Nursing associate professional) 3222 (Midwifery associate professional)
Midwife	A person who has been assessed and registered by a state midwifery regulatory authority or similar regulatory authority. They offer care to childbearing women during pregnancy, labour and birth, and during the postpartum period. They also care for the newborn and assist the mother with breastfeeding. Their education lasts three, four or more years in nursing school, and leads to a university or postgraduate university degree, or the equivalent. A registered midwife has the full range of midwifery skills *(22)*.	Registered midwife, midwife, community midwife	2222 (Midwifery professional)
Nurse	A graduate who has been legally authorized (registered) to practise after examination by a state board of nurse examiners or similar regulatory authority. Education includes three, four or more years in nursing school, and leads to a university or postgraduate university degree, or the equivalent. A registered nurse has the full range of nursing skills.	Registered nurse, nurse practitioner, clinical nurse specialist, advance practice nurse, practice nurse, licensed nurse, diploma nurse, nurse clinician	2221 (Nursing professional)

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

Fig. 4 is an overview of the different personas that may be involved in the delivery of ANC services, with the addition of obstetrician/gynaecologist specialist doctors. The data and decision-support content within this DAK focuses on the competencies and recommended interventions for ANMs, nurses and midwives.

2.2 Related personas

In addition to the targeted personas detailed above, there may be value in exploring other cadres and personas within the context of ANC services, such as associate clinicians and obstetricians. However, these were not identified as the central personas for the data and decision-support content detailed in this DAK. Additional personas related to the role of the targeted nurse midwife are listed in *Table 3*.

FIG. 4

Overview of the different personas that may be involved in the delivery of antenatal care services

Source: WHO (2012) *(22)*.

Digital Adaptation Kit for Antenatal Care

World Health Organization

Table 3. Additional personas related to the role of the targeted nurse midwife

Name	Description	Different Names	ISCO Code (if relevant) (23)
Pregnant woman	Pregnant women are the primary clients receiving antenatal care (ANC) services from the targeted health worker personas. While this is a diverse population group with different demographics, psychological and social needs, they generally have the following expectations from ANC programmes: » maintaining a healthy pregnancy for mother and baby (including preventing and treating risks, illness and death); » having an effective transition to positive labour and birth; » maintaining physical and sociocultural normality; » achieving positive motherhood (including maternal self-esteem, competence, autonomy) (12,24). Specific considerations in health service delivery will need to be incorporated for pregnant women and girls from certain population groups, including, but not limited to: adolescent girls and young women, women and girls living with HIV, and women and girls with poor access to health-care facilities. The content specifications for pregnant women will become even more important as additional client-side digital functionalities (e.g. on-demand information services, targeted client communication [reminders], reporting of health system feedback by clients on the quality of care, personal health tracking) are incorporated.	Client	N/A
Lay health worker	Any health worker who performs functions related to health-care delivery, was trained in some way in the context of the intervention but has received no formal professional or paraprofessional certificate or tertiary education degree (22).	Community health volunteer, village health worker, treatment supporter, promotors, etc.	3259 (Health associate professionals not elsewhere classified)
Community health worker	Community health workers provide health education, referral and follow-up; case management and basic preventive health care; and home visiting services to specific communities. They provide support and assistance to pregnant women and their families in navigating the health and social services system (23).	Health extension worker	3253 (Community health workers)
Nurse/Midwife supervisor	Nurse/midwife supervisors coordinate and manage the nurses and midwives within their catchment area, including through a review of their monthly reports and disseminating clinical protocols.	*Bidan* coordinator	N/A
Facility manager	Facility managers plan, direct, coordinate and evaluate the provision of clinical and community health services at the health-care facility. They provide overall direction, policy standards and operational criteria for the units they manage, including supervising and evaluating the recruitment, training and work activities of personnel. They monitor the use of health services and resources at the health-care facility. They liaise with other health and welfare service providers, boards (including community boards) and funding bodies to coordinate the provision of services.	Health facility administrator	1342 (Health service managers)

N/A: not applicable.

Generic personas

RECOMMENDATIONS
PERSONAS
SCENARIOS
WORKFLOWS
DATA
DECISIONS
INDICATORS
REQUIREMENTS

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

2.3 Additional considerations for contextualizing personas

Although this section provides an overview of the generic roles of the targeted personas, it is important to contextualize these personas to the specific setting. The generic personas described above can be supplemented by reflecting on the following additional considerations.

» **Background and demographics** (e.g. gender, age, whether they are from the community, familiarity with digital devices, do they own a mobile phone/smartphone).

» **Local environment** and any relevant contextual information about their surroundings (e.g. work-site characteristics; rural or urban; availability of electricity, water, Internet; distance from nearest referral facility).

» **Expected roles and responsibilities:** What are the expected roles and responsibilities based on country context? How does this differ from the roles and responsibilities defined by WHO?

» **Actual roles and responsibilities:** What are their actual roles and responsibilities, if there is any difference from what is expected?

» **Context:** What is the level of Internet connectivity? How are they compensated? How far away is the nearest referral facility? What other personas/ health workers do they interact with?

» **Challenges:** What are the day-to-day challenges the end-user might face?

» **Motivations:** What does success look like to them? Are there targets they need to achieve?

See *Annex 1* for examples of contextualized personas. For more details on persona development, please refer to the WHO *Handbook for digitalizing primary health care (17)*.

Digital Adaptation Kit for Antenatal Care

World Health Organization

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

Component 3 User scenarios
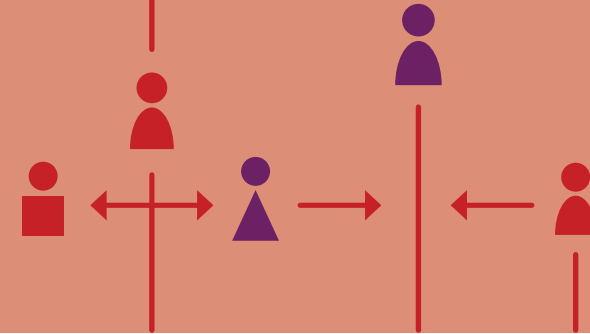
User scenarios are a narrative description of how different personas would interact with each other. The user scenario is provided to help the reader better understand how the system will be used and how it would fit into existing workflows. The following illustrative examples provide scenarios that may be common within ANC. In the subsequent component on workflows, these types of scenarios will be presented in a visual diagram, as opposed to narrative form. Note: these scenarios are not exhaustive and are only intended to contextualize the workflows in *Component 4*.

3.1 User scenario for first antenatal care contact

Key Personas	**Nurse:** *Jane* **Client:** *Charity, pregnant woman aged 24* **Registration Clerk:** *Abraham*

After missing her last menstrual cycle and feeling nauseous, Charity seeks care at the nearby government health centre. This is Charity's first time coming to this health-care facility, and the clerk (Abraham) confirms that they have no record of her on file. He asks her to provide him with basic demographic information, including her date of birth, alternative contact information, and address, to register Charity into the system and provide her with a QR code that she can use in case she returns to the facility for her following ANC appointments.

Once Charity is fully registered, she waits for a nurse (Jane) to call her into the counselling room. While Jane closes the door and lowers the shade on the window to provide privacy, Jane begins to ask questions regarding Charity's reason for coming to the facility, as well as the date of her last menstrual period (LMP). Charity is unsure of the exact date but recalls that it was around the new year holiday. Jane administers a test to confirm Charity's pregnancy. Upon confirming the positive pregnancy test, Jane proceeds to ask more detailed questions on Charity's occupation, behaviours (such as smoking and caffeine intake), general health status, and obstetric history. This process could also include questions on support systems (such as family, women's groups, financial or nutritional assistance). Based on the information Charity provides regarding her LMP, Jane is not able to conclude the exact gestational age but estimates her to be between 12 and 15 weeks. Jane lets Charity know that she would need an ultrasound as soon as possible, before her 24th week of pregnancy, to better estimate her gestational age and due date.

After recording Charity's background information in the digital system, Jane asks additional questions about any current symptoms. Jane also records Charity's weight and height measurements and conducts a physical exam, including taking her blood pressure to check that it is within the normal range. As Jane is recording these results in the digital system, she receives prompts to make sure she is providing the appropriate counselling and action. These prompts can also include reminders such as treating all pregnant women respectfully and without judgement, regardless of background or health status. Jane also orders any required additional tests such as those for diabetes, hepatitis and HIV, being sure to inform Charity about all the tests being done and to answer any questions she has about them.

Jane completes the counselling and advises Charity to reduce her caffeine intake and use a condom as she is still at risk from sexually transmitted infections (STIs) while pregnant. Jane also provides Charity with a supply of iron and folic acid (IFA) tablets to take daily. Jane also discusses different options for managing symptoms (e.g. nausea, lower back pain) as well as how to recognise danger signs that require contacting a health-care facility right away; Jane gives this information in a manner that encourages Charity to feel confident about making informed decisions about her and her baby's health. After checking whether Charity has any questions, Jane schedules the next ANC contact based on the suggested dates proposed by the digital system. Since there is no ultrasound at Jane's facility, Jane also provides Charity with a referral slip so that she can get her ultrasound done at the imaging centre before she returns for her next contact. Charity will also receive a text (SMS) reminder (assuming she has given consent during her registration) ahead of her next scheduled contact.

Corresponding business processes (see Component 4)	This scenario refers to the following business processes: A. Registration B. Routine ANC contact

3.2 User scenario for second antenatal care contact

Key Personas	**Nurse midwife:** *Amina* **Client:** *Charity, pregnant woman aged 24* **Registration Clerk:** *Mary*

Charity returns to the health centre within two weeks of her previous contact, which was not planned according to the system. Charity gives the clerk (Mary) the card with the QR code that she was given at her last contact. Mary can search for and find Charity's record, but immediately sees that she is too weak to stand up on her own. She calls the nurse midwife (Amina) for assistance so that she can begin checking to see what is wrong. Charity explains to Amina that she has had heavy vaginal bleeding over the past week. Amina performs a rapid evaluation of Charity's general condition (vital signs, blood loss, etc.). Based on these findings, she decides to conduct further clinical examination and initial treatment at this facility. She also asks Mary to arrange for a local taxi driver to take Charity – in case a referral is necessary.

Corresponding business processes (see Component 4)	This scenario refers to the following business processes: A. Registration B. Routine ANC contact C. Referral

3.3 User scenario for an adolescent client

Key Personas	Nurse midwife: *Sutapa Apa* Client: *Manideepa* Registration Clerk: *Aslam Bibi*

Adolescent Manideepa, who is 18 years old, comes to the health-care facility accompanied by her mother-in-law. The registration clerk (Aslam Bibi) asks her for her date of birth. Once the clerk registers her date of birth, the digital system automatically calculates that Manideepa is 18 years old and prompts Aslam Bibi. The registration clerk takes note of this and discusses this with the health worker later. He enrols her as a new client. Once Mandeepa and her mother-in-law enter the examination room, the health worker closes the door and lowers the shade on the window to maintain visual and auditory privacy. As Suptapa, the health worker, opens Manideepa's record on her password-protected tablet, she receives a pop-up message reminding her that Manideepa is an adolescent client and that she should conduct the **home, education, activities/employment, drugs, suicidality and sex (HEADSS) assessment**.

After an initial encounter with Manideepa and her mother-in-law, the health worker asks the mother-in-law to leave the examination room so she can develop rapport with Manideepa. Sutapa has forgotten the key components of a "HEADSS assessment", so she clicks on an information icon with the pop-up message that contains some information on the types of questions she should ask. In accordance to the HEADSS assessment, **the health worker asks Manideepa a series of questions starting with non-threatening questions. To help build rapport, she asks Manideepa who she lives with, how is school, and what activities she does in her free time**. Sutapa obtains consent to conduct a physical exam. She then asks more clinically important questions, such as when her last menstrual period was, about her past pregnancy or obstetric history, whether she suffers from any chronic illnesses, whether she was vaccinated when she was young (including for Human papillomavirus (HPV)), whether she has had any laboratory tests and whether she takes any medication. Then Suptapa conducts the physical exam. She checks Manideepa's height, weight, blood pressure and pulse rate. Then the health worker examines the height of the uterus (symphysis-fundal height) and finds Manideepa to be about four months pregnant. Suptapa advises her to have an ultrasound scan as soon as possible and then provides the first dose tetanus toxoid-containing vaccination (TTCV). She gives Manideepa iron and folic acid and calcium tablets, explains about good food and nutrition, and asks her to sleep under an insecticide-treated bednet. She also describes the options for self-managing symptoms (such as constipation, pelvic pain) and how to decide when to contact a health-care facility if the symptoms persist or if danger signs arise. Then Suptapa asks Manideepa to come for a follow-up contact as per the schedule prescribed in the guidelines. She then enquires whether Manideepa would like to receive a text reminder for the contacts. She also explains that because of Manideepa's young age she should give birth at a health-care facility and not at home. Sutapa also takes the opportunity to counsel Manideepa on other critical components of an ANC and discusses the options for postpartum family planning, birth preparedness, and breastfeeding. Sutapa logs all of this information into her digital tool so she can remember what counselling Manideepa will need the next time she sees her.

Corresponding business processes (see Component 4)	This scenario refers to the following business processes: A. Registration B. Routine ANC contact

World Health Organization

3.4 How to interpret user scenarios for functional requirements

User scenarios are helpful tools not only to better understand the context in which a digital tool would operate, but also to provide some insights into what key data elements would need to be recorded and accounted for in the database. Additionally, the context in which the tool would be used, illustrated by the user scenarios, provides insight into some functional and non-functional requirements that the system would also need. For example, in the user scenario for an adolescent client (section 3.3), highlighted in yellow are key data elements that need to be recorded and/or calculated. Highlighted in blue are some elements of decision-support logic that can be automated in the system. Highlighted in green are some key functional and non-functional requirements that should be included in the system, and **bolded** are some adolescent-specific considerations that should be accounted for.

For example, the interpretation of the user scenario for an adolescent client (3.3) is shown in Table 4.

Table 4. Interpretation of a user scenario

Data elements to be collected	Decision-support logic to be embedded	Functional and non-functional requirements	Adolescent-specific considerations which should be "triggered" if the client's entered age is 19 years or younger
» Date of birth » Age » New client or returning client » Marital status » Last menstrual period » Past pregnancy or obstetric history » History of chronic illnesses » Vaccination history (including HPV) » Laboratory tests conducted » Current medications » Risk factors » Height » Weight » Blood pressure » Pulse rate » Gestational age » Services, medication and supplements provided	» Calculation of age based on date of birth » Decision-support logic to trigger certain pop-ups and reminders based on the client's age » Calculation of body mass index (BMI)	» Password protection » User management (login system) » Pop-up messages ("toaster messages") and reminders » Information icon for more detailed information and guidance » Recording data for later use	» Creating a private environment » Home, education, activities/employment, drugs, suicidality and sex (HEADSS) assessment guidance » HPV vaccination history

RECOMMENDATIONS
PERSONAS
SCENARIOS
WORKFLOWS
DATA
DECISIONS
INDICATORS
REQUIREMENTS

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

Component 4 # Business processes and workflows
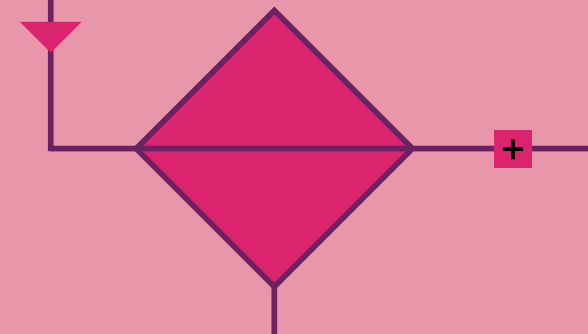
A **business process**, or simply "process", is a set of related activities or tasks performed together to achieve the objectives of the health programme area, such as registration, counselling, referrals *(14)*. Workflows are a visual representation of the progression of activities (tasks, interactions, decision points) that are performed within the business process *(15)*. The workflow provides a "story" for the business process being diagrammed and is used to enhance communication and collaboration among users, stakeholders and engineers.

Table 5 provides an overview of the key business processes conducted by the ANM/midwife persona within ANC service delivery. The workflows for these business processes are detailed in this section. Additionally, for each of these business processes, the data elements and decision-support needs are detailed within components 5 (*core data elements*) and 6 (*decision-support logic*) of this DAK.

Note: The DAK currently provides the data elements and decision-support logic for business processes A (registration) and B (routine ANC contact). The components for the remaining processes will be detailed in future versions. In addition, business processes A, B and C assume ANC to be provided at the facility level and business process D is at the community level. If there are other service-delivery models the country is using based on their context, these can then be modified accordingly.

Table 5. Overview of key ANC processes

	Process Name	Process ID	Personas	Objectives	Task set
	Title	ID used to reference this process throughout the DAK	Individuals interacting to complete the process	A concrete statement describing what the process seeks to achieve	The general set of activities performed within the process
A	Registration	ANC.A	» Woman (may or may not yet be confirmed to be pregnant) » Data entry clerk or » Auxiliary nurse midwife (ANM) or nurse midwife	To identify and register a pregnant woman so that she can proceed to the ANC consultation	**Starting point: Woman arrives at clinic[a]** » Quick check to ensure the woman does not need urgent medical attention » Query pregnant woman's health record » Register pregnant woman's details » Update record with registration information, if needed
B	Routine ANC contact	ANC.B	» Pregnant woman » ANM or nurse midwife	To counsel and provide ANC services to pregnant woman	**Starting point: Woman has been registered and is ready to begin ANC contact** » Record health history » Assess danger signs » Assess current pregnancy conditions, including symptoms, physical exam and lab tests » Case management or referral » Schedule follow-up contact » Provide counselling on all health topics necessary (e.g. nutrition, HIV testing, family planning, psychosocial and support services)
C	ANC Referral	ANC.C	» Pregnant woman » ANM or nurse midwife » Referral health-care provider	To provide timely and appropriate referrals to a higher-level facility or health-care provider	**Starting point: Woman requires referral** » Assess pregnant woman's danger signs » Stabilize pregnant woman's condition » Arrange emergency transport » Liaise with next level facility for care upon arrival
D	ANC health promotion, follow-up in the community	ANC.D	» Pregnant woman » ANM or nurse midwife » Community health worker	To provide routine health promotion and follow-up within the community	**Starting point: Woman receives community/home-based contact** » Visit pregnant woman at home or provide outreach in the community » Conduct basic assessment » Determine referral to facility » Distribute commodities (e.g. iron and folic acid, supplements, condoms for protection against STIs)

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

Process Name	Process ID	Personas	Objectives	Task set
Title	ID used to reference this process throughout the DAK	Individuals interacting to complete the process	A concrete statement describing what the process seeks to achieve	The general set of activities performed within the process
E Reporting on aggregate indicators	ANC.E	» ANM or nurse midwife » ANM/nurse supervisors » Facility manager » District manager	Compile and submit relevant data contributing to indicators and other reporting needs on a routine basis	**Starting point: Time for periodic (usually monthly) reporting** » Tally and compile required data (if on paper) » Check data quality » Correct fixable errors » Track loss to follow-up and monitor upcoming contacts for pregnant women in the catchment area » Generate and review aggregate reports » Submit to supervisor/director for approval » Provide feedback and any changes required
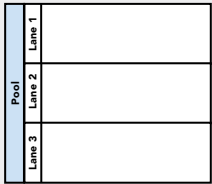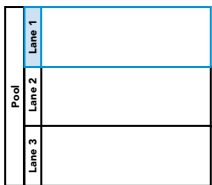
a   As this DAK is focused on ANC, we will refer to this individual as "woman/pregnant woman" although data elements in the registration workflow will use the term "client" for consistency across other DAKs as the registration workflow is a general process across all health service delivery.

Source: Adapted from PATH *(13)*.

4.1 Overview of key processes

The workflows are structured using the standardized notations for business process mapping detailed in Table 6.

Table 6. Business process symbols used in workflows

Symbol	Symbol name	Description
	Pool	A **pool** consists of multiple "swim lanes" that depict all the individuals or types of users that are involved in carrying out the business process or workflow. Diagrams should be clear, neat and easy for all viewers to understand the relationship across the different swim lanes. For example, a pool would depict the business process of conducting an outreach activity, which involves multiple stakeholders represented by different lanes in that pool.
	Swim lane	Each individual or type of user is assigned to a **swim lane**, a designated area for noting the activities performed or expected by that specific actor. For example, an antenatal care health worker may have one swim lane; the supervisor would be in another swim lane; the clients/patients would be classified in another swim lane.

Digital Adaptation Kit for Antenatal Care

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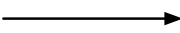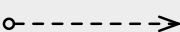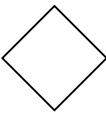
Symbol	Symbol name	Description
○	Start event or Trigger event	The workflow diagram should contain both a **start** and an end **event**, defining the beginning and completion of the task, respectively.
◯	End event	There can be multiple **end events** depicted across multiple swim lanes in a business process diagram. However, for diagram clarity, there should only be one end event per swim lane.
▭	Activity, Process, Step or Task	Each **activity** should start with a verb, e.g. "Register client", "Calculate risk". Between the start and end of a task, there should be a series of activities noting the successive actions performed by the actor in that swim lane. There can also be subprocesses within each activity.
▭⊞	Activity with subprocess	This denotes an activity that **has a much longer subprocess** to be detailed in another diagram. If the diagram starts to become too complex and unhelpful, the subprocess symbol should be used to reference another process depicted on another page.
▭▤	Activity with business rule	This denotes a decision-making activity that requires the business rule, or decision-support logic, to be detailed in a "decision-support table". This means that the logic described in the decision-support table will come into play during this activity as outlined in the business process. This is usually reserved for complex decisions.
⟶	Sequence flow	This denotes the flow direction from one process to the next. The end event should not have any output arrows. All symbols (except start event) may have an unlimited number of input arrows. All symbols (except end event and gateway) should have one and only one output arrow. All other symbols should have one output arrow leading to a new symbol, looping back to a previously used symbol or to the end event symbol. Connecting arrows should not intersect (cross) each other.
○⇠⇠⇢	Message flow	This denotes the flow of data or information from one process to another. This is usually used for when data are shared across swim lanes or stakeholder groups.
◇	Gateway	This symbol is used to depict a fork, or decision point, in the workflow, which may be a simple binary (e.g. yes/no) filter with two corresponding output arrows, or a different set of outputs.
		There should only be two different outputs that originate from the decision point. If you find yourself needing more than two "output" or sequence flow arrows, you most likely are trying to depict "decision-support logic" or a "business rule". This should be depicted as an "Activity with business rule" (above) instead.
◉➡	Throw – Link	The "**Throw – Link**" serves as the start of an off-page connector. It is the end of the process when there is no more room on your page for that workflow. It is the end of a process on your current page or the end of a subprocess that is part of a larger process. There will need to be a "Catch – Link" that follows the "Throw – Link".
◉⇨	Catch – Link	The "**Catch – Link**" serves as the end of an off-page connector. It is the start of the new process on a different page from the "Throw – Link" or the start of a subprocess that is part of a larger process. There needs to be a "Throw – Link" that is aligned to the "Catch – Link".
▭~	Ad hoc subprocess	An **ad hoc subprocess** can contain multiple tasks. One or more tasks in this shape should be performed, and they can be performed in any order. However, not all of these activities need to be finished before moving on to the next activity.

RECOMMENDATIONS
PERSONAS
SCENARIOS
WORKFLOWS
DATA
DECISIONS
INDICATORS
REQUIREMENTS

Fig. 5. Overview of key ANC processes[a]
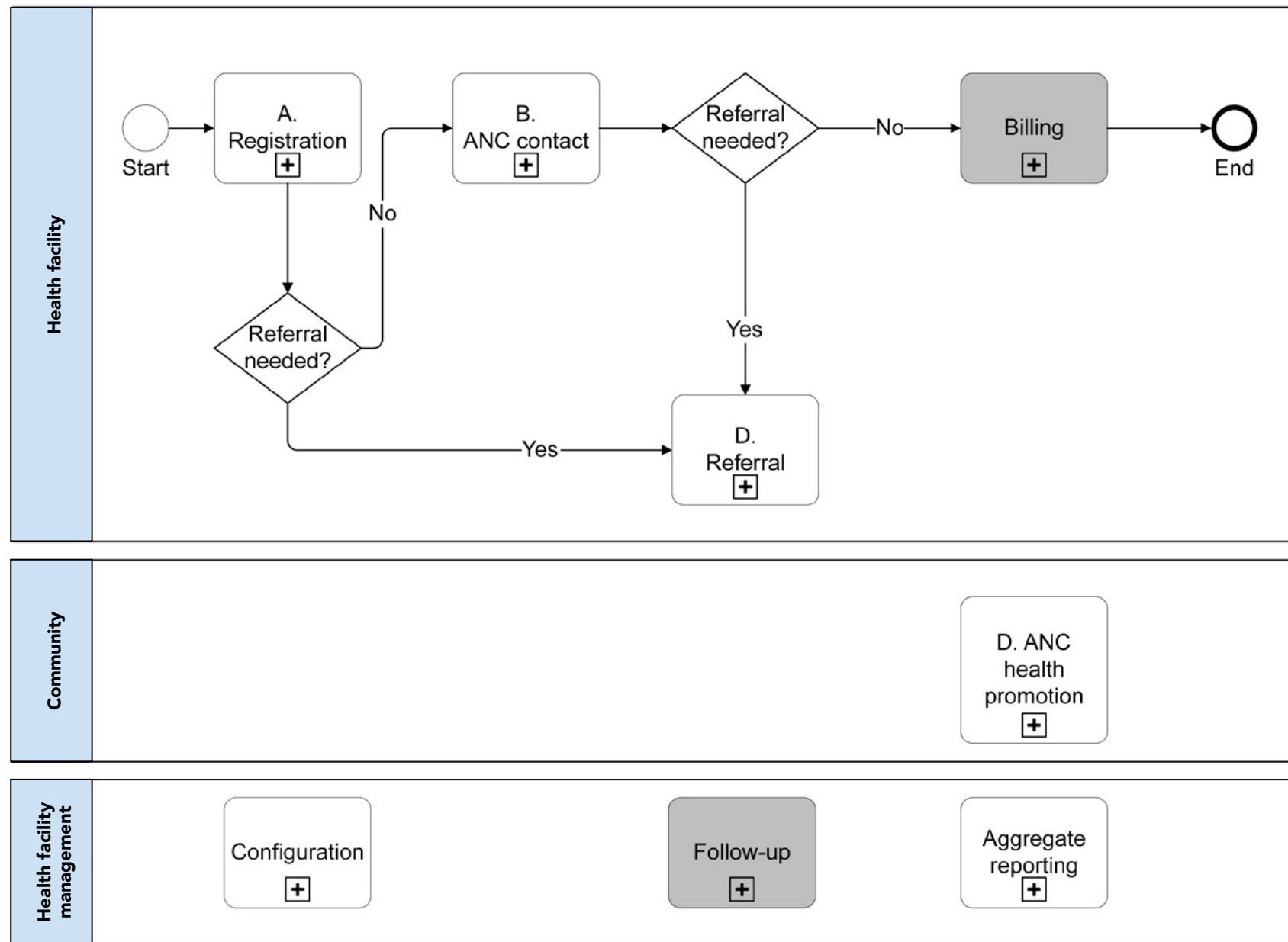
Grey boxes are not covered in this DAK.

[a] For key, see Table 6 (page 30).

4.2 Workflows

The workflows that follow depict processes that have not been generalized across different contexts and may not reflect the variability and nuances across different settings. The simplicity of the workflow may not adequately illustrate the non-linear steps that may occur. These workflows are considered to be workflows to be "80% complete," whereby the "other 20 %" will need to be done through a series of human-centred design methods and mechanisms to complete the workflows for an implementation.

A.　Business process for registration

Objective: To identify and register a pregnant woman so that she can proceed to the ANC consultation.

Fig. 6. Workflow: Registration business process[a]
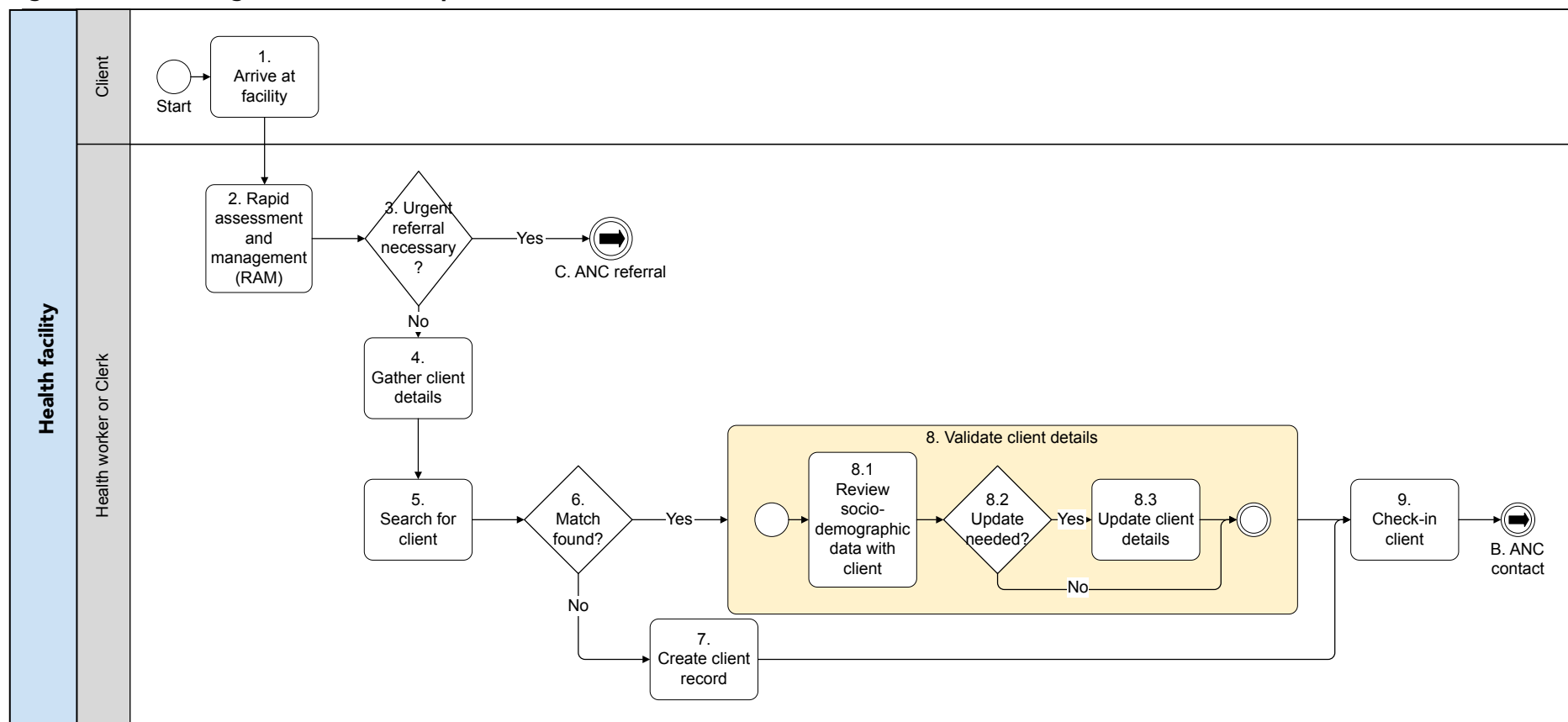
[a] For key, see Table 6 (page 30).
Source: Adapted from PATH *(13)*.

Business processes and workflows

RECOMMENDATIONS
PERSONAS
SCENARIOS
WORKFLOWS
DATA
DECISIONS
INDICATORS
REQUIREMENTS

REGISTRATION BUSINESS PROCESS NOTES AND ANNOTATIONS

General note

Registration may be conducted as a stand-alone process by a data clerk/ administrative persona ahead of the ANC encounter with a clinical health-care provider or it may be conducted directly by the health-care provider as part of the overall ANC encounter.

1. Arrive at facility
» Woman arrives at the facility.
» She may or may not have an identification card with her.
» Client could already be registered at the health-care facility for another service.

2. Rapid assessment and management (RAM)
» The registration clerk or the first health worker the woman encounters assesses for any possible visible danger signs.
» *Note: there could be decision-support logic input here as well, but for the reference content we have determined that RAM is outside of the scope of this ANC DAK.*

3. Urgent referral necessary?
» Determine whether urgent referral is required based on the RAM.
» If yes, initiate referral (see Business process C: ANC referral).

4. Gather client details
» The health worker or data clerk searches for the woman's name using available identifiers.
» Ask the client whether they have previously been issued a unique identifier.
» Does the client have an identification card/number/barcode?
» Does client say whether she is a returning or a referred client?
» If a referral, check for referral slip or data from the community.
» Determine whether the client is new to the health-care facility/health post.
» For returning clients, details will be retrieved from the registry of clients at this facility or, if possible, from a central client registry.

5. Search for client
» This search process can be done through a variety of means depending on what mechanisms are available in country. For example, clients can be searched for by using their name, unique identifier, a QR code or even biometrics.

6. Match found?
» If multiple records are found and no unique ID, provide option to merge records.

7. Create client record
» Issue a unique identifier, if used and possible at the facility.

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8. Validate client details

» Review and update client record.

8.1. Review sociodemographic data with client
Review client's non-clinical information – name, address, contact information, etc.

8.2. Update needed?
Has the client moved? Has she changed her contact information or has any other sociodemographic information changed?

8.3. Update client details
Client can provide updated information if she has recently moved or changed other details.

» Merge/update client records.

» May also happen during counselling process.

» In some contexts, this may be linked to billing needs.

9. Check in client

» The pregnant woman waits in line to be called by the health worker for the ANC contact.

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS
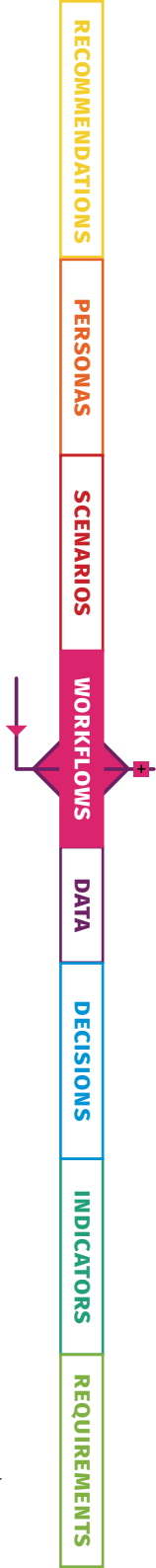
B.   Business process for ANC contact

Objective: To counsel and provide routine ANC services to pregnant women.

Fig. 7. Workflow: ANC contact[a]

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Flowchart

13. Self-care interventions in the home or community

14. Woman returns? — Yes / No → End

12. Scheduling

11. Referral needed? — No / Yes → C. ANC referral

10. Counselling, in-facility management & treatment

- 10.1 Behaviour counselling
- 10.2 Physiological symptoms counselling
- 10.3 Diet counselling
- 10.4 Diagnosis & treatment
- 10.5 Nutrition supplementation
- 10.6 Risk reduction & general counselling
- 10.7 Immunizations
- 10.8 Intimate partner violence first-line treatment and care
- 10.9 Deworming & malaria counselling & prophylaxis

~

SRH: sexual and reproductive health.

a For key, see Table 6 (page 30).

Source: Adapted from PATH *(13)*.

ANC CONTACT BUSINESS PROCESS NOTES AND ANNOTATIONS

General note

» Woman arrives at the facility is shown here to depict the completeness of an ANC contact.

» Woman arrives at health-care facility to be seen by a health worker.

» The registration process is to record administrative and demographic information as detailed in Business process A: registration.

» The general registration step may not need to be done at each contact if ANC services are being provided in a community setting or the woman is being followed up by the same health worker.

Reminder for all health workers:

Follow respectful maternity care principles when delivering ANC care, treating **all** pregnant women (regardless of background or health status) respectfully and non-judgmentally. For further training on respectful maternity care and effective provider-client communication, see *www.qualityofcarenetwork.org/knowledge-library*.

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1. Rapid assessment and management (RAM)

» The registration clerk or the first health worker the woman encounters assesses for any visible danger signs.

2. Danger signs needing referral?

» Health worker determines whether the woman presents symptoms or health concern requiring an urgent referral based on RAM.

» If referral is needed, health worker refers immediately based on danger signs presented and proceeds to Business process C: ANC referral.

3. Confirm pregnancy

» Pregnancy can be confirmed using a urine dipstick test or by a blood test.

» This task is optional later in pregnancy.

4. First contact

» Health worker determines whether this is the woman's first ANC contact or if she is returning for a follow-up.

5. Quick check

» Health worker assesses woman to see whether there are any danger signs that warrant in-facility management or referral, or if possible, to proceed with the routine ANC contact.

6. Collect woman's profile and history

» If this is the woman's first ANC contact, the health worker records information on her current pregnancy, past medical and obstetric history, medications, behaviour, immunization status and other background information.

7. Check symptoms and follow up

» Health worker follows up on any previously reported behaviours, medications and symptoms. Steps 8–10 below are all conducted within the ANC assessment.

8. Conduct physical exam

» Health worker conducts a physical exam for weight, height (if first contact), maternal exam and fetal assessment.

9. Conduct laboratory test and imaging

» Health worker orders or follows up on required laboratory tests and ultrasound, as necessary.

» Health worker informs woman of all tests ordered and explains why.

10. Counselling, in-facility management and treatment

» Based on the previous steps, health worker provides counselling for potential risk, behaviours and diagnoses, as well as preventive services and any treatment that can be provided at the facility, including through admission to a different part of the facility.

» When providing counselling about treatment options, symptom management, healthy behaviours, and making a birth plan, provide the woman with options where possible to give her the knowledge and ability to make decisions about her and her baby's health. Also, provide clear directions on when to contact health worker or facility if danger signs arise or self-management of symptoms is not satisfactory.

» Provide counselling and treatment for:

– hospital referral;

– behaviour counselling (caffeine reduction, tobacco cessation, second-hand smoke reduction, condom use, alcohol/substance use);

– physiological symptoms (nausea and vomiting relief, heartburn, constipation, lower back or pelvic pain, varicose veins, oedema);

– diet and exercise (healthy eating, protein intake);

– diagnostics (hypertension, HIV, hepatitis B, hepatitis C, syphilis, asymptomatic bacteriuria [ASB], diabetes, anaemia, tuberculosis, diabetes in pregnancy, Rh factor testing, blood typing);

– risk (pre-eclampsia risk, HIV risk, diabetes risk, danger signs);

– ANC contact schedule;

– birth plan;

– postpartum family planning;

– breastfeeding;

– prevention (anaemia, deworming, malaria prophylaxis, immunizations [TTCV, flu]);

– vitamin supplementation (iron and folic acid, calcium, vitamin A)

  * dietary supplements not recommended include:

    • high protein supplement

    • vitamin B6 supplement

    • vitamins C and E supplement

    • vitamin D supplement.

11. Referral needed?

» If there are any diagnoses requiring referral or services that cannot be provided at the facility, health worker refers pregnant woman based on findings during counselling.

» These services could also include psychosocial, emotional, cultural and social support services to help the pregnant woman. Examples of these services are psychosocial counselling, peer-support organizations, and social service organizations for financial assistance, nutrition assistance and education, and childcare.

12. Scheduling

» If a referral is not required, health worker schedules follow-up contact.

13. Self-care interventions in the home or community

» Woman monitors her pregnancy and general condition until the next interaction with the health-care provider (follow-up contact, delivery or symptom/health concern). She also self-manages physiological symptoms and health behaviours, including diet and exercise, following the options promoted by the provider during counselling (step 10).

» If danger signs arise or physiological symptoms of pregnancy persist even after the woman tries the self-management options, the woman should contact a health worker and/or facility.

14. Woman returns

» Woman either comes back for follow-up services or is referred until delivery.

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

C. Business process for ANC referral

Objective: To provide timely and appropriate referrals to a higher-level facility or health-care provider.

Fig. 8. Workflow: ANC referral[a]

[a] For key, see Table 6 (page 30).
Source: PATH *(13)*.

End

8.
Receives
woman

9.
Emergency
obstetric care

End

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS
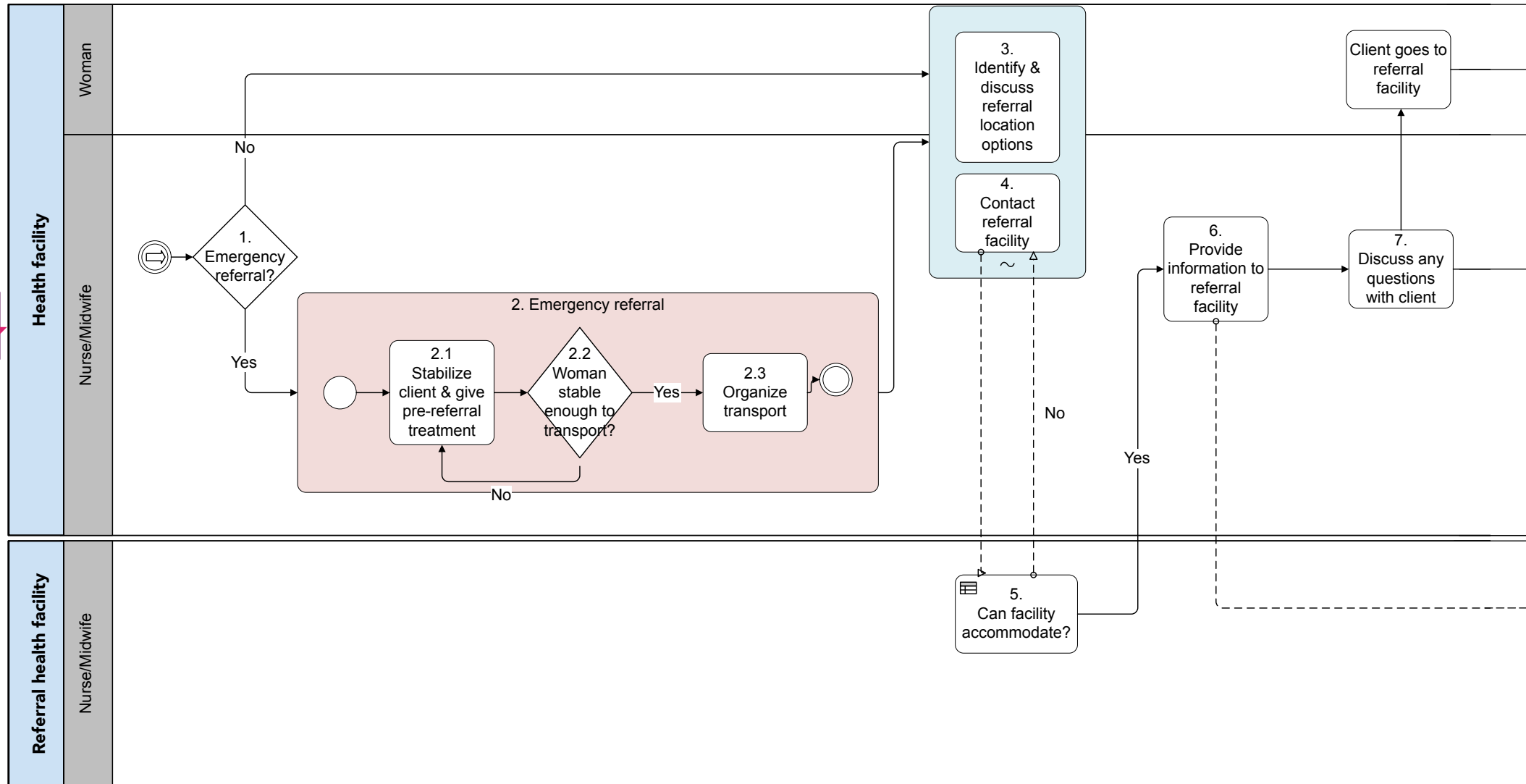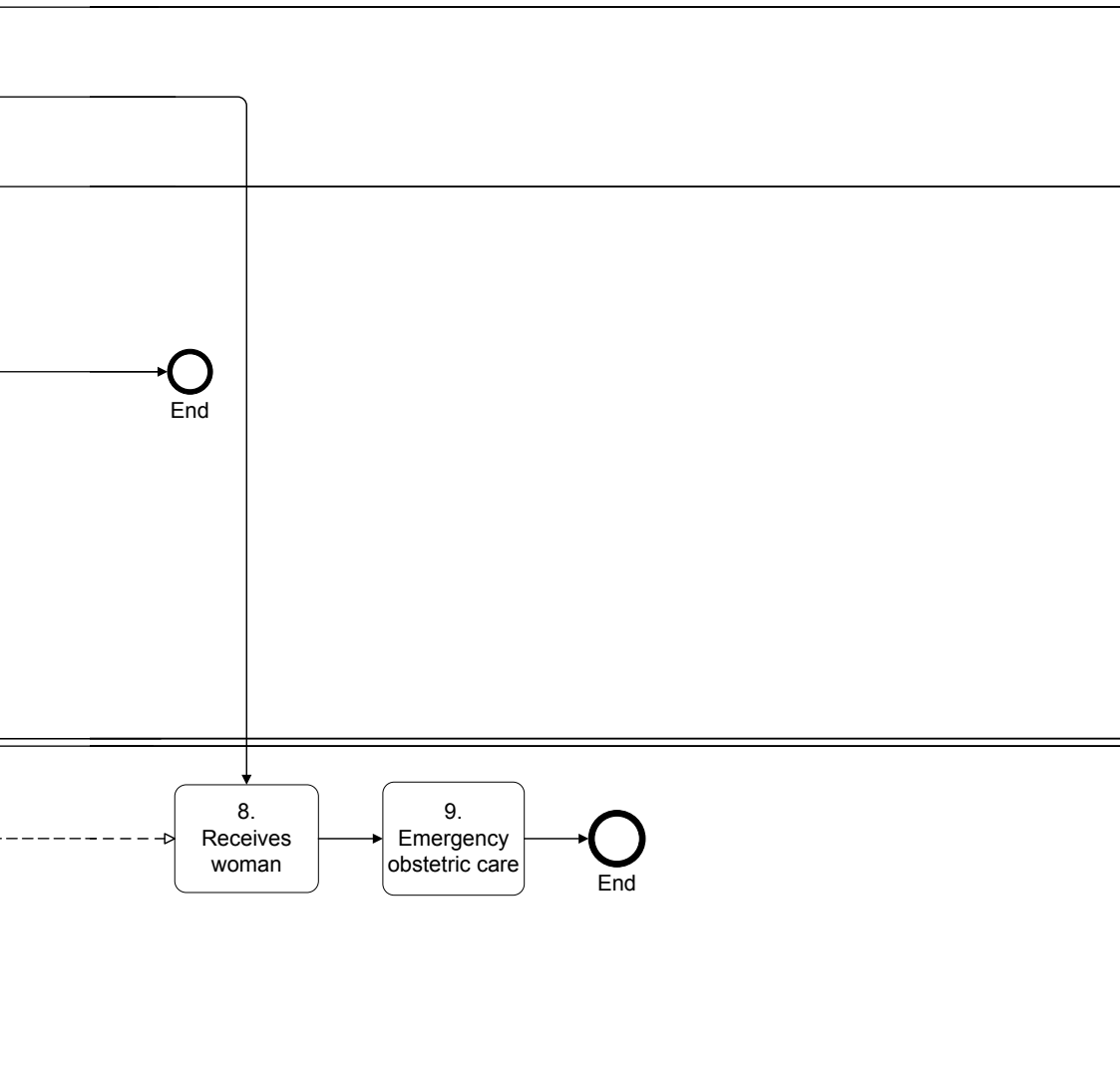
ANC REFERRAL BUSINESS PROCESS NOTES AND ANNOTATIONS

General notes

Examples of reasons why a referral may be needed include:

» the health worker cannot perform the "service" (e.g. facility is not equipped for specific service);

» there is an emergency and the client needs immediate referral;

» the woman presents risk factors that cannot be managed at the health-care facility.

1. Emergency referral?

» If woman needs an immediate referral due to an emergency situation, bypass standard referral steps.

» In the case of an emergency, a referral can be made at any time including during registration, counselling and service provision.

2. Emergency referral

2.1 Stabilize woman and give prereferral treatment.

The woman is assumed to need emergency referral if her condition requires immediate medical attention.

Thus, stabilize the woman's condition and provide any necessary treatment.

2.2 Is the woman stable enough to transport?

Once the woman is stable enough to transport, then immediately transport.

If the woman is still not stable, provide prereferral treatment for stabilization.

2.3 Organize transport

Organize emergency transport for the woman. For emergency referrals, the health-care facility arranges transport usually by phoning for an ambulance or other vehicle.

3. Identify and discuss referral location options

» In discussion with the woman and her relatives, decide on where she will be referred. Discussions include:

– how to get to the referral facility, including location and transportation options;

– who to see and what is likely to happen;

– follow-up on return, if needed.

» If there are various possible referral facilities, either the woman or her relatives should indicate their preferred referral location.

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World Health Organization

4. Contact referral facility

» Health workers should contact the referral facility to determine whether that facility can accommodate such a referral and to ensure the woman is treated as soon as possible upon arrival.

5. Can referral facility accommodate?

» Check whether the referral facility can accommodate the woman and provide the services she needs.
» If the referral facility can accommodate the woman, move on to step 6: "Provide information to referral facility".
» Otherwise, find a different facility that can accommodate the woman.
» A system can be set up to validate that a facility has both the supplies and skills to accommodate the woman.

6. Provide information to referral facility

» Make appointment, if necessary.
» Woman or family arranges own transport.
» For emergency referrals, the health-care facility arranges transport – usually by phoning for an ambulance or other vehicle.
» Fill out referral form, which can include notification of the referral destination.
» Provide the necessary clinical, sociodemographic and identity information to the referral facility.
» This can be done digitally if the appropriate systems are in place.

7. Discuss any questions with client

» Discuss any questions or concerns the woman may have.

For adolescents:

» If an unaccompanied adolescent woman needs a referral, ensure that a responsible adult is sent as an accompanying person.

8. Receipt of client

» Referral facility receives woman along with all the necessary clinical, sociodemographic and identification information.
» Once the referral facility receives the woman, move to provide services at the receiving referral facility (Business process B: ANC contact).

9. Emergency obstetric care

» Provide necessary care.

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

D. Business process for ANC health promotion follow-up in the community

Objective: To provide routine health promotion and follow-up within the community.

Fig. 9. Workflow: ANC health promotion follow-up in the community[a]

[a] For key, see Table 6 (page 30).
Source: PATH *(13)*.

Digital Adaptation Kit for Antenatal Care

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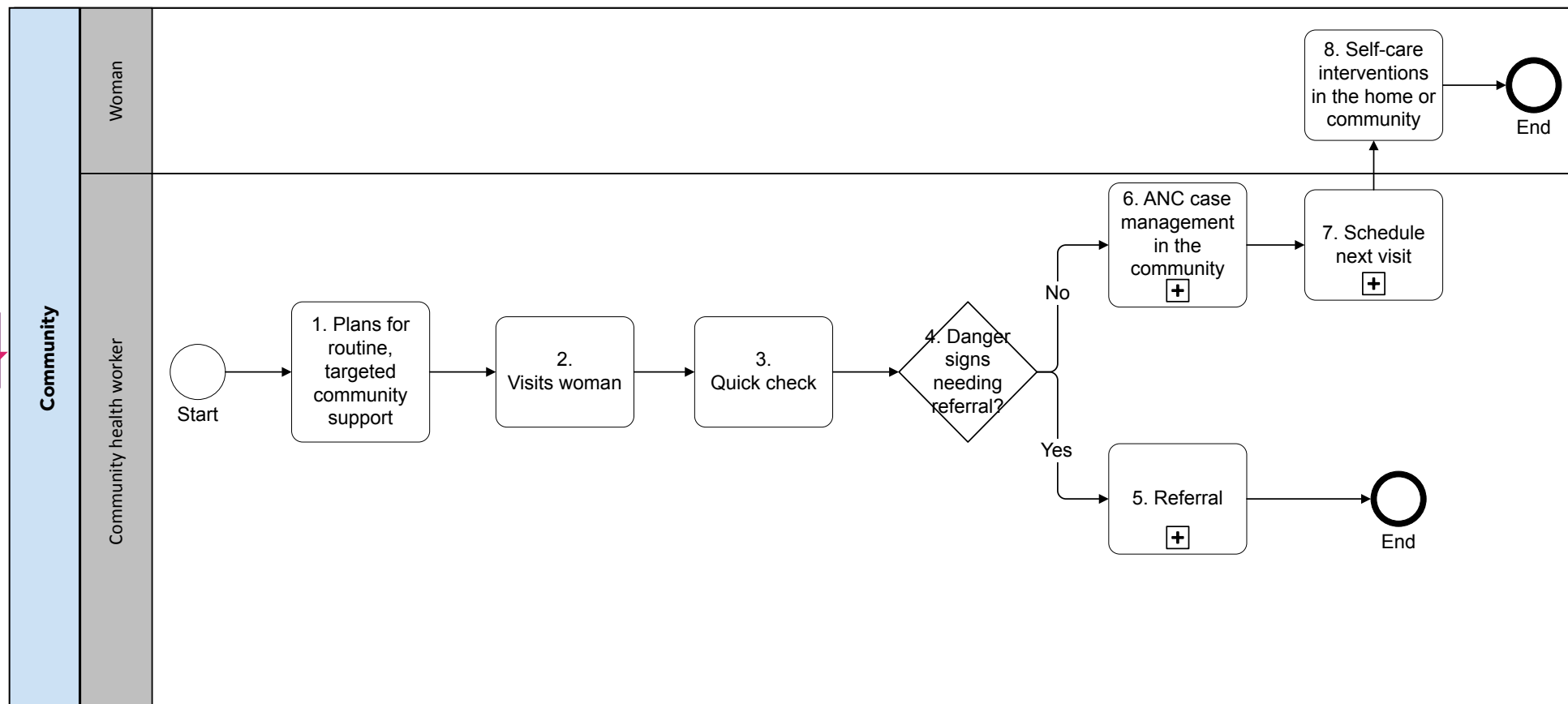
ANC HEALTH PROMOTION FOLLOW-UP IN THE COMMUNITY BUSINESS PROCESS NOTES AND ANNOTATIONS

General notes
» Community health workers (CHWs) regularly provide outreach services to the community.
» These same workers are linked to and supervised by facility staff, to ensure continuity of care and referral.
» CHW tasks and responsibilities will vary from country to country depending on national and subnational ANC policies.

1. Plans for routine, targeted community support
» CHW plans outreach activities, including equipment and supplies (e.g. iron and folic acid supplementation, vaccines, condoms) and any information, education and communication materials.

2. Visits woman or sees her at community day
» The CHW visits the woman during community day and/or at her home (depending on the context).

3. Quick check
» Assess for any possible danger signs, and the woman's informal (e.g. family, friends) and formal (e.g. community women's groups, nutritional or financial assistance, childcare) support systems.
» Determine whether she needs additional support.

4. Danger signs needing referral?
» CHW determines whether the woman presents symptoms or concerns requiring an urgent referral.

5. Referral
» Conduct the referral if needed. Also, provide additional referrals to services that help the pregnant woman. Examples of these services are psychosocial counselling, peer-support organizations, and social service organizations for financial assistance, nutrition assistance and education, and childcare.

6. ANC case management in the community
» Provide counselling on the topics below, enquiring about which strategies the woman has used to manage symptoms and which healthy behaviours she has adopted or plans to use. Then, discuss additional options or reinforcing behaviours, answer any questions and encourage the woman on continuing to make informed decisions for:

   – referral to nearest facility, if necessary;
   – behaviour counselling (caffeine reduction, tobacco cessation, second-hand smoke reduction, condom use, alcohol/substance use);
   – physiological symptoms (nausea and vomiting relief, heartburn, supplements, constipation, lower back or pelvic pain, varicose veins, oedema)
   – diet and exercise (healthy eating, protein intake);
   – ANC contact schedule;
   – birth plan;
   – postpartum family planning;
   – breastfeeding.

» Where allowed, provide treatment for:

   – prevention (anaemia, deworming, malaria prophylaxis, immunizations [TTCV, flu])
   – Vitamin supplementation (iron and folic acid, calcium, vitamin A).

7. Schedule next contact
» If a referral is not required, CHW schedules follow-up contact/appointment, at either community or facility level.

RECOMMENDATIONS
PERSONAS
SCENARIOS
WORKFLOWS
DATA
DECISIONS
INDICATORS
REQUIREMENTS

8. Self-care interventions in the home or community

» Reminds woman of danger signs and shares emergency transport information, if available.

» Woman monitors her pregnancy and general condition until the next interaction with the CHW or the health-care provider (follow-up contact, childbirth or symptom/health concern). She self-manages physiological symptoms and health behaviours, including diet and exercise, following the options promoted by the health workers during counselling (step 6). If physiological symptoms of pregnancy persist even after the woman tries the self-management options, the woman should contact the CHW and/or facility.

E.   Business process for reporting on aggregate indicators

Objective: Compile and submit relevant data contributing to indicators and other reporting needs on a routine basis.

Fig. 10. Reporting on aggregate indicators[a]
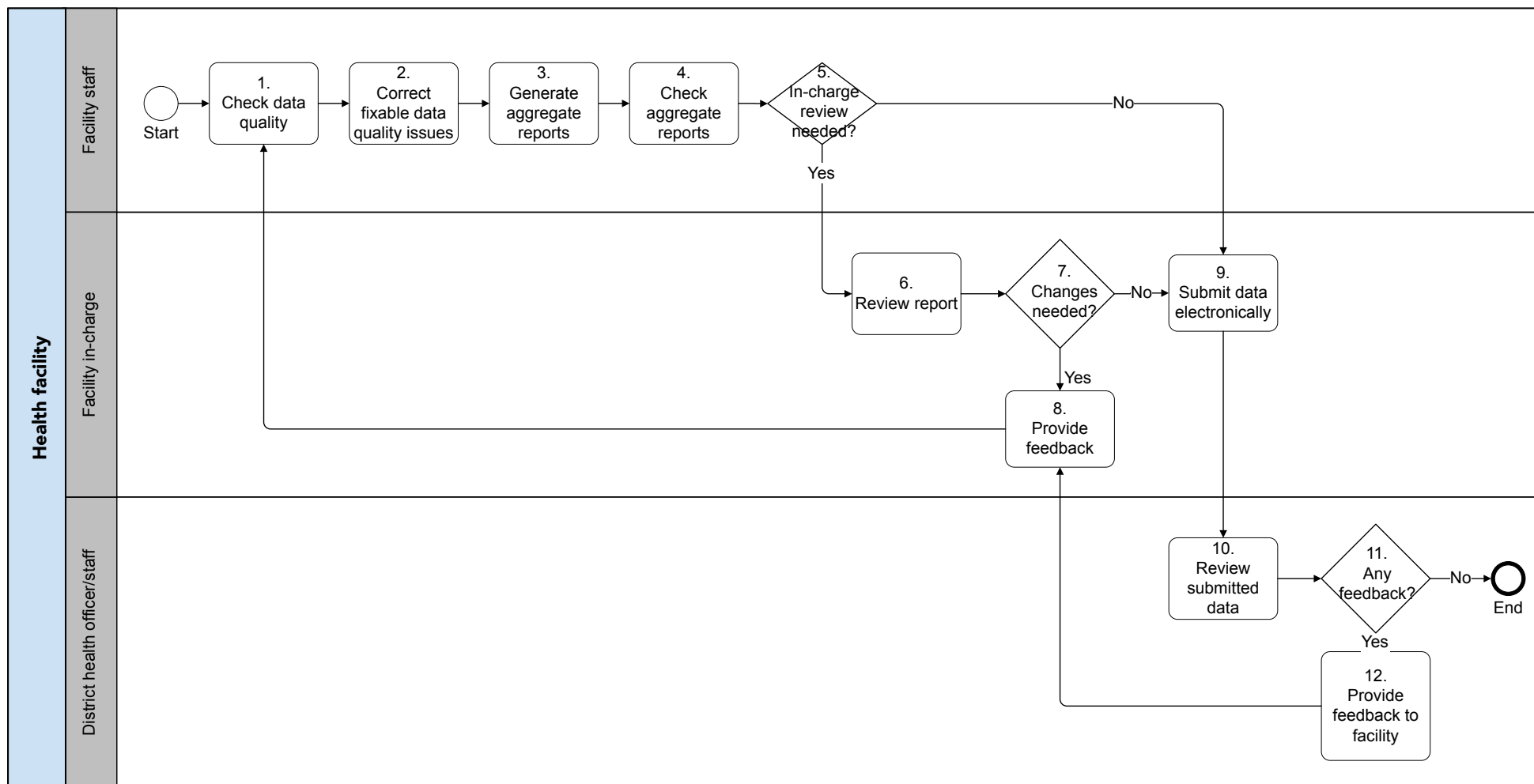
[a] For key, see Table 6 (page 30).
Source: PATH *(13).*

1. Check data quality
» Health-care facility reviews accuracy, validity and completeness of data in system.

2. Correct fixable data quality issues
» Depending on local policy this step might not be required.

3. Generate aggregate reports
» This can be automated and done digitally.

4. Check aggregate reports
» Depending on local policy this step might not be required.

5. Facility supervisor/in-charge review needed?
» Determine whether the report needs to be reviewed by the person in charge of the facility.

6. Review report
» The reports are reviewed by facility supervisor/in-charge.

7. Changes needed?
» Determine whether the report is accurate or has any issues.

8. Provide feedback
» If there is any issue with the report, the person in charge will provide feedback to the responsible person to make corrections to client-level data.

9. Submit data electronically
» Reports and data may be used by the facility supervisor/in-charge or staff at multiple points during the business process, such as here, earlier in the process or outside of the business process.
» This can be automated and done digitally.
» Depending on the local policies, an active "submission" may not be needed, and the district-, provincial- and national-level MOH would be able to access data directly for reporting purposes.

10. Review submitted data
» Use data in report to review progress and make decisions on improvements and actions to take.

11. Any feedback?
» Determine whether there is any feedback after review of the data.

12. Provide feedback to facility
» If there is any feedback, the focal person will provide the feedback to the facility. If there are errors, the facility may be required to restart the process and resubmit.

4.3 Additional considerations for adapting workflows

Although these workflows can be considered as a starting point, it is helpful to conduct further validation through interviews with the targeted personas or shadowing their work to obtain a better sense of the differences that would need to be reflected in the digital system. The *WHO Handbook for digitalizing primary health care (17)* can help in the development of new workflows or revisions to existing workflows.

Component 5 — Core data elements
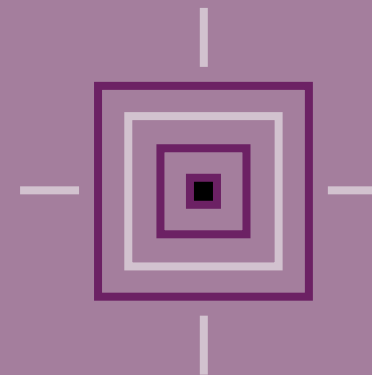
This section outlines the core set of data elements corresponding to different points of the workflow within the identified business processes. These data elements provide the foundation for executing the decision-support logic, as well as populating indicators and performance metrics. Although this section provides a high-level overview of included data elements, a more complete "data dictionary" (in spreadsheet form) detailing the input options, calculations, validation checks and linked to standardized terminology codes, such as ICD and SNOMED, is available in *Web Annex A*. This data dictionary also includes data elements for configuring the decision support logic according to parameters, such as prevalence of certain conditions (e.g. malaria, HIV prevalence, etc.) and health system characteristics (e.g. availability of ultrasound and other commodities).

5.1 Simplified list of core data elements

Table 7 provides a simplified list of core data elements and is merely a snapshot of the comprehensive data dictionary found in *Web Annex A*. As with the workflows, we view this data dictionary as "80% generic" with the expectation that the "other 20%" will be supplemented and modified through country adaptation.

Note: The data needs for the registration process have been combined with the data needs within the ANC contact process as these may often be done in tandem by the same health-care provider.

Table 7. Workflow core data elements for identified business processes

Activity ID. Activity name	Data element ID	Data element name	Description and definition
Business process ANC.A: Registration			
ANC.A1. **Arrive at facility**	N/A – No data is recorded during this activity		
ANC.A2. **Rapid assessment and management**	N/A – No data is recorded during this activity		
ANC.A3. **Urgent referral needed**	N/A – No data is recorded during this activity		
ANC.A4. **Gather client details**	ANC.A4.DE1	Unique identification	Unique identifier generated for new clients or a universal ID, if used in the country
	ANC.A4.DE2	First name	Client's first name
	ANC.A4.DE3	Last name	Client's family name or last name
	ANC.A4.DE4	Contact date	The date and time of the client's contact
	ANC.A4.DE5	Date of birth (DOB)	Client's DOB, if known
	ANC.A4.DE6	Age	Age (number of years) of the client based on the DOB
	ANC.A4.DE7	Address	Client's home address or address that the client is consenting to disclose
	ANC.A4.DE8	Mobile phone number (optional)	Client's mobile phone number
	ANC.A4.DE9	Woman wants to receive reminders during pregnancy? (optional)	Whether or not the woman wants to receive SMS or other messages regarding her ANC contacts and health status during pregnancy
	ANC.A4.DE10	Alternative contact's name	Name of an alternative contact, which could be next of kin (e.g. partner, mother, sibling); the alternative contact would be used in the case of an emergency situation
	ANC.A4.DE11	Alternative contact's phone number	Phone number for the alternative contact
	ANC.A4.DE12	Co-habitants	Who the client lives with (e.g. parents [in cases of adolescents], partner, extended family, siblings, friend[s], no one)
ANC.A5. **Search for clients**	N/A – No data is recorded during this activity		
ANC.A6. **Match found**	N/A – No data is recorded during this activity		

Digital Adaptation Kit for Antenatal Care

World Health Organization

Activity ID. Activity name	Data element ID	Data element name	Description and definition
ANC.A7. Create client record	N/A – No data is recorded during this activity		
ANC.A8. Validate client details	N/A – No data is recorded during this activity		
ANC.A9. Check-in client	N/A – No data is recorded during this activity		
Business process ANC.B: ANC contact			
ANC.B1. Arrive at facility	N/A – No data is recorded during this activity		
ANC.B2. Registration	See ANC.A: Registration		
ANC.B3. Rapid assessment and management	N/A – No data is recorded during this activity		
ANC.B4. Confirm pregnancy	ANC.B4.DE1	Pregnancy confirmed?	
ANC.B5. Quick check	ANC.B5.DE1–DE4	Reason for coming to facility	Records the reason why the woman came to the health-care facility today
	ANC.B5.DE5–DE47	Specific health concern(s)	If the woman came to the facility with a specific health concern, select the health concern(s) from the list
	ANC.B5.DE48–DE62	Danger signs	Before each contact, the health worker should check whether the woman has any of the danger signs listed here – if yes, she should refer to the hospital urgently; if no, she should continue to the normal contact

Activity ID. Activity name	Data element ID	Data element name	Description and definition
ANC.B6. Collect women's history and profile	ANC.B6.DE1–DE6	Highest level of education achieved	Highest level of schooling the client has reached
	ANC.B6.DE7–DE13	Occupation	The woman's occupation (select all that apply)
	ANC.B6.DE14–DE17	Gestational age (GA)	GA in weeks and/or days depending on the source of gestational age
	ANC.B6.DE18–DE22	Source of gestational age	How the gestational age was calculated (e.g. last menstrual period [LMP], ultrasound, symphysis-fundal height [SFH] or abdominal palpation)
	ANC.B6.DE23–D26	Number of pregnancies (gravida)	Total number of times the woman has been pregnant (including this pregnancy) and their outcomes
	ANC.B6.DE27–DE33	Whether last live birth was preterm	Was the last live birth preterm? Whether the last live birth was preterm (i.e. less than 37 weeks gestation at the time of delivery)
	ANC.B6.DE34–DE50	Past pregnancy complications	Mark whether the woman has had any complications or problems in any previous pregnancy
	ANC.B6.DE51–DE56	Substance use during past pregnancy	Type of substances used during past pregnancies
	ANC.B6.DE57–DE71	Allergies	Indicate allergies the woman may have
	ANC.B6.DE72–DE82	Past surgeries	Woman's prior surgeries
	ANC.B6.DE83–DE99	Existing chronic health conditions	Current chronic health conditions or problems the woman may have
	ANC.B6.DE100–DE104	Tetanus toxoid-containing vaccine (TTCV) immunization history	Woman's history of receiving TTCV
	ANC.B6.DE105–DE108	Flu immunization history	Whether or not this year's seasonal flu vaccine has been provided
	ANC.B6.DE109–DE138	Current medications	Medications the woman is currently taking
	ANC.B6.DE139–DE144	Daily caffeine intake	Assesses whether the woman consumes more than 300 mg of caffeine per day
	ANC.B6.DE145-DE152	Current alcohol and/or substance use	Whether or not the woman currently consumes any alcohol or substances
	ANC.B6.DE153-DE155	Tobacco use or exposure	Whether the woman uses tobacco products
	ANC.B6.DE156-DE161	Partner HIV status	HIV status of the woman's partner (reported)

Digital Adaptation Kit for Antenatal Care

World Health Organization

Activity ID. Activity name	Data element ID	Data element name	Description and definition
ANC.B7. Symptoms and follow-up	ANC.B7.DE1–DE8	Medication follow-up	Medications (including supplements and vitamins) the woman is still taking
	ANC.B7.DE9–DE17	Persistent behaviours	Behaviours that persist after being reported during last contact
	ANC.B7.DE18–DE42	Persistent physiological symptoms	Physiological symptoms that persist after being reported during last contact
	ANC.B7.DE43–DE70	Current physiological symptoms	Physiological symptoms that the woman is currently experiencing
	ANC.B7.DE71–DE97	Intimate partner violence (IPV) signs and symptoms	Presenting signs and symptoms that trigger clinical enquiry of IPV
	ANC.B7.DE98–DE101	Fetal movement	Whether the woman has felt the baby move or not or if the baby's movements have decreased
ANC.B8. Physical exam	ANC.B8.DE1–DE4	Height and weight	Current height in centimetres, pre-gestational weight in kilograms, and current weight in kilograms, and calculation of body mass index (BMI)
	ANC.B8.DE5–DE9	Weight category	Weight category calculated based on BMI
	ANC.B8.DE10–DE16	Expected weight gain	Expected weight gain during pregnancy is based on the woman's weight category
	ANC.B8.DE17–DE26	Blood pressure	Woman's systolic and diastolic blood pressure (mmHg), or reason blood pressure cannot be taken
	ANC.B8.DE27–DE33	Symptom of severe pre-eclampsia	Check if the woman has symptoms of severe pre-eclampsia
	ANC.B8.DE34-35	Body temperature	The woman's body temperature (°C)
	ANC.B8.DE36–DE37	Pulse rate	The woman's pulse rate (beats per minute)
	ANC.B8.DE38	Pallor present	Whether or not the woman has pallor
	ANC.B8.DE39–DE49	Respiratory exam	The woman's respiratory condition based on respiratory exam
	ANC.B8.DE50–DE60	Cardiac exam result	The woman's cardiac condition
	ANC.B8.DE61–DE70	Breast exam result	Whether or not the result of the breast exam is normal
	ANC.B8.DE71–DE78	Abdominal exam result	Whether or not the result of the abdominal exam is normal
	ANC.B8.DE79–DE93	Pelvic exam result	Whether or not the result of the visual pelvic exam is normal

Activity ID. Activity name	Data element ID	Data element name	Description and definition
ANC.B8. Physical exam	ANC.B8.DE94–DE99	Oedema present	Whether or not the woman has oedema, and if so the type of oedema
	ANC.B8.DE100–DE104	Oedema severity	Severity of the oedema
	ANC.B8.DE105–DE110	Fetal assessment	Symphus-fundal height, whether health worker observes a fetal heartbeat, and record heart rate
	ANC.B8.DE111–DE116	Fetal presentation	If a single fetus only, indicate the presentation of the fetus in the uterus
	ANC.B8.DE117–DE120	Presenting signs/conditions for IPV	Signs or conditions (based on physical exam) that trigger suspicion of IPV
	ANC.B8.DE121–DE128	Clinical enquiry for IPV	Whether or not clinical enquiry for IPV was conducted based on presenting signs and symptoms and conditions
	ANC.B8.DE129–DE133	Types of IPV	What type(s) of violence has the woman been subjected to

Digital Adaptation Kit for Antenatal Care

World Health Organization

Activity ID. Activity name	Data element ID	Data element name	Description and definition
ANC.B9. **Conduct laboratory tests and imaging**	ANC.B9.DE1–DE9	Ultrasound scan	Whether ultrasound scan is required, has been ordered or date performed; or reason why required ultrasound scan was not done
	ANC.B9.DE9–DE12	Amniotic fluid level	Amniotic fluid level detected during ultrasound scan
	ANC.B9.DE13–DE20	Placenta location	Location of the placenta detected during the ultrasound scan
	ANC.B9.DE21–DE28	Blood type	Whether a blood type test was ordered and the woman's blood type
	ANC.B9.DE29–DE31	Rh factor	Woman's Rhesus (Rh) factor
	ANC.B9.DE32–DE47	HIV status	Whether an HIV test was done, the date of the HIV test, test result and diagnosis; or reason HIV test was not done
	ANC.B9.DE48–DE58	Partner HIV status	Whether partner's HIV test was done or status is known, test result and diagnosis; or reason HIV test was not done
	ANC.B9.DE59–DE76	Hepatitis B	Whether hepatitis B test was done, type of test, test result and diagnosis; or reason hepatitis B test was not done
	ANC.B9.DE77–DE94	Hepatitis C	Whether hepatitis C test was done, type of test, test result and diagnosis; or reason hepatitis C test was not done
	ANC.B9.DE95–DE112	Syphilis	Whether syphilis test was done, type of test, test result and diagnosis; or reason syphilis test was not done
	ANC.B9.DE113–DE158	Urine	Whether urine test was done, type of test, test result (leukocytes, nitrites, protein), and asymptomatic bacteria diagnosis; or reason urine test was not conducted
	ANC.B9.DE159–DE174	Blood glucose and diabetes diagnosis	Whether blood glucose test was done, type of test, test result, and gestational diabetes mellitus (GDM)/diabetes mellitus (DM) in pregnancy diagnosis; or reason the blood glucose test was not done
	ANC.B9.DE175–DE192	Blood haemoglobin	Whether blood haemoglobin test was done, type of test, test result, and anaemia diagnosis; or reason blood haemoglobin test was not conducted
	ANC.B9.DE193–DE214	Tuberculosis (TB) screening	Whether TB screening was done, TB screening results; or reason TB screening was not done
ANC.B10. **Counselling and treatment**		See decision-support tables in *Component 6* and *Web Annex B*	
ANC.B11. **Referral needed?**		See ANC.C: Referral	
ANC.B12. **Scheduling follow-up contact**		See Decision-support scheduling logic in *Component 6* and *Web Annex B*	
ANC.B13. **Self-care interventions in the home or community**		N/A – No data currently recorded during this activity	

Core data elements

RECOMMENDATIONS
PERSONAS
SCENARIOS
WORKFLOWS
DATA
DECISIONS
INDICATORS
REQUIREMENTS

Activity ID. Activity name	Data element ID	Data element name	Description and definition
Business process ANC.C: Referral			
ANC.C1. **Emergency referral?**	ANC.C1.DE1	Emergency referral	Whether the referral is for urgent care
ANC.C6. **Provide information to referral facility**	ANC.C6.DE2–DE5	Reason for referral	Reason why the client is being referred; if diagnosed, this may include the diagnosis
	ANC.C6.DE6	Treatment given before referral	Was any treatment provided before referral?
	ANC.C6.DE7	Date of scheduled referral	When the referral is scheduled
	ANC.C6.DE8	Location of referral	Where the client is being referred to
	ANC.C6.DE9	Date referral was made	The date the referral was made
	ANC.C6.DE10	Provider who made referral	The name of the provider who made the referral
	ANC.C6.DE11– ANC.C6.DE12	Provider's facility and phone number	Facility client is being referred from, and contact details of the provider making the referral
	ANC.C6.DE13	Referral notes	Any additional relevant details of clinical significance for the referral facility to provide continuity of care

N/A, not applicable.

Digital Adaptation Kit for Antenatal Care

World Health Organization

5.2 List of calculated data elements

The section above outlines the core data elements that should be included in digital systems to facilitate the decision-support logic or indicators. There are additional derived data elements that are based on calculations of the core data elements above (Table 8).

Table 8. Derived data elements

Calculated data element label	Core data elements used for calculation (i.e. the "variables")	Calculation
Estimated due date (EDD) based on last menstrual period (LMP)	ANC.B6.DE19. Last menstrual period (LMP)	LMP + 280 days
Gestational age (GA) based on LMP	ANC.B6.DE19. Last menstrual period (LMP)	([Today's date] – LMP) / 7
Body mass index (BMI)	ANC.B8.DE1. Height ANC.B8.DE2. Pre-gestational weight ANC.B8.DE3. Current weight	([Pre-gestational weight (kg)] / [{Height (centimetres)/100}^2])
Total weight gain (kg)	ANC.B8.DE2. Pre-gestational weight ANC.B8.DE3. Current weight	(Current weight (kg)) – ([Pre-gestational weight (kg)] OR [Current weight at first contact])

5.3 Additional considerations for adapting the data dictionary

Some settings may require the inclusion of additional data elements into the full dataset or changes to response options based on contextual differences. Additionally, the transition from paper-based forms to digital systems may require some reflection on whether data elements currently on the paper forms should be incorporated into the digital system. The following table provides an initial list of characteristics anticipated for each implementation to review and customize based on the national guidelines and local context (see Table 9).

Table 9.

Data element ID	Point of customization and configuration	Description
Population characteristics		
ANC.Config.1	Population prevalence of undernourishment	The proportion of women in the adult population (18 years or older) with a BMI less than 18.5
ANC.Config.2	Population prevalence of anaemia	The proportion of pregnant women in the population with anaemia (haemoglobin level less than 11 g/dl)
ANC.Config.3	Population with low dietary calcium intake	Women in the population are likely to have low dietary calcium intake (less than 900 mg of calcium per day)
ANC.Config.4	Population prevalence of tuberculosis (TB)	The tuberculosis prevalence in the general population in number of cases per 100 000 persons or greater

Data element ID	Point of customization and configuration	Description
ANC.Config.5	Population with vitamin A deficiency	Vitamin A deficiency is a severe public health problem if 5% or more of women in a population have a history of night blindness in their most recent pregnancy in the previous 3–5 years that ended in a live birth, or if 20% or more of pregnant women have a serum retinol level below 0.70 µmol/L
ANC.Config.6	Population prevalence of soil-transmitted helminth infection	The percentage of individuals in the general population infected with at least one species of soil-transmitted helminth
ANC.Config.7	Population incidence of HIV in the absence of PrEP	HIV incidence in number of cases per 100 person-years
ANC.Config.8	Population prevalence of HIV in pregnant women	The proportion of pregnant women in the population who are HIV positive
ANC.Config.9	Population prevalence of HIV in key populations (men who have sex with men, people in prison or other closed settings, people who inject drugs, sex workers and transgender people)	The proportion of individuals in each of the key populations who are HIV positive
ANC.Config.10	Malaria-endemic setting	Whether the setting is a malaria-endemic setting
ANC.Config.11	Population prevalence of syphilis in pregnant women	The proportion of pregnant women in the population with syphilis
ANC.Config.12	Population prevalence of hepatitis B	The proportion of hepatitis B seroprevalance in the general population
ANC.Config.13	Population prevalence of hepatitis C	The proportion of hepatitis C virus antibody seroprevalance in the general population
Site-specific characteristics		
ANC.Config.14	Minimum requirements for IPV assessment	WHO does not recommend universal screening for violence of women attending health services. WHO does encourage health-care providers to raise the topic only with women who have injuries or conditions that they suspect may be related to violence. All of the following must be in place at the health facility for this to be TRUE: a. A protocol or standard operating procedure for intimate partner violence (IPV) b. A health worker trained on how to ask about IPV and how to provide the minimum response or beyond c. A private setting d. A way to ensure confidentiality e. Time to allow for appropriate disclosure AND f. A system for referral in place.
ANC.Config.15	Ultrasound available at the health-care facility	Is an ultrasound machine available and functional at your facility and a trained health worker available to use it?

World Health Organization

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

Decision-support logic

Component **6**

The decision-support logic component of the adaptation kit provides the decision-support logics and algorithms, as well as the scheduling of services, in accordance with WHO guidelines. In this DAK, the decision-support logics and algorithms deconstruct the recommendations within the WHO ANC guidelines into a format that clearly labels the inputs and outputs, along with any actions required, that would be operationalized in a digital decision-support system.

6.1 Decision-support logic overview

This section first provides an overview and inventory of all the decision-support tables (*Table 10*) across the ANC contact workflow. The listed decision-support tables are expanded in greater detail to specify the inputs and conditions that would result in a decision output and action, such as a referral, treatment or counselling. The structure of the decision-support tables is based on an adaptation of the Decision Model Notation (DMN), an industry standard for modelling and executing decision-support logics *(25)*. The DMN format of the decision-support tables reflects IF/THEN statements. *Tables 11* and *12* provide examples of the expanded decision-support tables; the full set of decision-support tables is found in *Web Annex B*.

Table 10. Overview of decision-support tables for ANC contact workflow (Workflow B)

Task	Decision-support table ID	Description	Reference/source
Danger signs	ANC.DT.01	Danger signs requiring referral	Pregnancy, childbirth, postpartum and newborn care guide (IMPAC) (2015): B2 *(26)*
HEADSS assessment	ANC.DT.02	Conduct HEADSS assessment if adolescent	Adolescent job aid: a handy desk reference tool for primary level health workers. (2010) *(27)*
Check symptoms	ANC.DT.03	Check symptoms and follow up on previous symptoms. Symptoms include: – non-pharmacological measures to relieve nausea and vomiting – pharmacological treatments for nausea and vomiting – heartburn – leg cramps – low back and pelvic pain – constipation – varicose veins and oedema counselling	WHO ANC recommendations (2016) *(8)* WHO consolidated self-care interventions guidelines (2019) *(29)* Pregnancy, childbirth, postpartum and newborn care guide (IMPAC) (2015) *(26)*
Conduct physical exam	ANC.DT.04	Conduct physical exams: depending on the output of the first reading, additional examination may be needed, including:	WHO ANC recommendations (2016): D.1–D.6 *(8)* Managing complications guide (IMPAC) (2017) *(28)*
	ANC.DT.05	Evaluating labour	Pregnancy, childbirth, postpartum and newborn care guide (IMPAC) (2015) – B2 *(26)*
Physical exam referral	ANC.DT.06	Physical symptoms and exam results requiring referral	Managing complications guide (IMPAC) (2017) *(28)*
Laboratory & imaging	ANC.DT.07	Ultrasound recommendation	WHO ANC recommendations (2016): B.2.4 *(8)*
	ANC.DT.08	HIV testing	WHO ANC recommendations (2016): B.1.7 *(8)*
	ANC.DT.09	Hepatitis B testing	Guidelines on hepatitis B and C testing (2017): Recommendation 6.1 *(31)*
	ANC.DT.10	Hepatitis C testing	Guidelines on hepatitis B and C testing (2017): Recommendation 6.1 *(31)*
	ANC.DT.11	Syphilis testing	WHO ANC recommendations (2016): B.1.7 *(8)*
	ANC.DT.12	Urine testing	Managing complications guide (IMPAC) (2017) *(28)* WHO ANC recommendations (2016) *(8)*
	ANC.DT.13	Tuberculosis screening	WHO ANC recommendations (2016): B.1.8 *(8)*
	ANC.DT.14	Other	Managing complications guide (IMPAC) (2017) *(28)*

Task	Decision-support table ID	Description	Reference/source
Behaviour counselling	ANC.DT.15	Behaviour counselling including: – caffeine reduction counselling – tobacco cessation counselling – second-hand smoke counselling – condom counselling – alcohol/substance use counselling	WHO ANC recommendations (2016): A.10, B.1.5, B.1.6 *(8)*
Dietary counselling	ANC.DT.16	Recommended dietary counselling for all women, with additional counselling required for underweight women	WHO ANC recommendations (2016): A.1, A.5–9 *(8)*
Diagnosis & treatment	ANC.DT.17	Pre-eclampsia, severe pre-eclampsia and hypertension diagnosis	Pregnancy, childbirth, postpartum and newborn care guide (IMPAC) (2015): C3 *(26)* Managing complications guide (IMPAC) (2017): S-53, S-61 *(28)* WHO pre-eclampsia and eclampsia recommendations (2011): 4, 6, 7 *(34)*
	ANC.DT.18	HIV diagnosis	WHO ANC recommendations (2016): B.1.7 *(8)* Consolidated guidelines on HIV testing services (2015) *(30)* Consolidated guideline on SRHR women with HIV (2017) *(33)*
	ANC.DT.19	Hepatitis B diagnosis	Guideline on hepatitis B and C testing (2017): Sections 16.6, 16.7 *(31)*
	ANC.DT.20	Hepatitis C diagnosis	Guideline on hepatitis B and C testing (2017): Section 16.5 *(31)*
	ANC.DT.21	Syphilis diagnosis	WHO ANC recommendations (2016): B.1.7 *(8)*
	ANC.DT.22	Asymptomatic bacteriuria (ASB) diagnosis	WHO ANC recommendations (2016): B.1.2 *(8)*
	ANC.DT.23	Gestational diabetes mellitus (GDM) and diabetes mellitus (DM) during pregnancy diagnosis	WHO ANC recommendations (2016): B.1.4 *(8)*
	ANC.DT.24	Tuberculosis (TB) diagnosis	WHO ANC recommendations (2016): B.1.8 *(8)*
Anaemia IFA	ANC.DT.25	Iron and folic acid supplementation recommended for treatment of anaemia and/or standard nutritional supplementation	WHO ANC recommendations (2016): A.2.1–5, B.1.1 *(8)* Pregnancy, childbirth, postpartum and newborn care guide (IMPAC) (2015): C4 *(26)*
Nutrition-Ca+VitA	ANC.DT.26	Calcium and vitamin A supplementation	WHO ANC recommendations (2016): A.3, A.4 *(8)*

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

Task	Decision-support table ID	Description	Reference/source
Risk reduction counselling	ANC.DT.27	Pre-eclampsia risk counselling	Pregnancy, childbirth, postpartum and newborn care guide (IMPAC) (2015): C3 *(26)* WHO pre-eclampsia and eclampsia recommendations (2011): 1–25 *(34)*
	ANC.DT.28	Gestational diabetes mellitus (GDM) risk counselling	WHO ANC recommendations (2016): B.1.4–10 *(8)*
	ANC.DT.29	HIV risk counselling	WHO ANC recommendations (2016): B.1.7, C.1 *(8)* Pregnancy, childbirth, postpartum and newborn care guide (2015): C4 *(26)* Consolidated guidelines on HIV testing services *(30)*
	ANC.DT.30	General risk reduction counselling	WHO ANC recommendations (2016): C.1, C.3 *(8)* Managing complications guide (IMPAC) (2017): S-11, S-15 *(28)* Pregnancy, childbirth, postpartum and newborn care guide (IMPAC) (2015) *(26)*
Recommended immunizations during pregnancy	ANC.DT.31	Flu immunization	Vaccines against flu position paper (2012) *(35)*
	ANC.DT.32	Tetanus toxoid immunization	WHO ANC recommendations (2016): C.5 *(8)* Maternal immunization against tetanus (2006) *(36)*
General counselling	ANC.DT.33	Breastfeeding counselling	Pregnancy, childbirth, postpartum and newborn care guide (IMPAC) (2015): K2 *(26)* WHO recommendations on intrapartum care (2018): Recommendation 49 *(37)*
	ANC.DT.34	Family planning counselling	Pregnancy, childbirth, postpartum and newborn care guide (IMPAC) (2015): C16 *(26)* Medical eligibility criteria for contraceptive use (2015) *(38)*
	ANC.DT.35	Birth plan counselling	Pregnancy, childbirth, postpartum and newborn care guide (IMPAC) (2015): C14 *(26)* WHO recommendations on health promotion interventions (2015): Recommendation 1 *(39)*
Intimate partner violence (IPV)	ANC.DT.36	IPV clinical enquiry	WHO ANC recommendations: B1.3 *(8)* IPV handbook (2014) *(40)* Responding to IPV (2013) *(41)*
	ANC.DT.37	IPV first-line support and care	WHO ANC recommendations: B1.3 *(8)* IPV handbook (2014) *(40)* Responding to IPV (2013) *(41)*
Deworming & malaria	ANC.DT.38	Deworming and malaria prophylaxis	WHO ANC recommendations (2016): C.4, C.6 *(8)*

Digital Adaptation Kit for Antenatal Care

World Health Organization

6.2 Decision-support tables

Each of the decision-support logics listed in the overview table (*Table 10*) is elaborated in the linked *web appendix*. These decision-support tables comprise of the following components described in Table 11.

Table 11. Components of the decision-support tables

Decision ID	The name of the "decision" describing what algorithm or logic is represented (e.g. pre-eclampsia risk counselling). The Decision ID should correspond to the number in the overview table (Table 10).		
Business rule	The description of the decision that needs to be made based on IF/THEN statements with the appropriate data element name for the variables. The rule should demonstrate the relationship between the input variables and the expected outputs and actions within the decision-support logic – e.g. if blood pressure is higher than 140 SBP/90 DBP, then the client should be flagged as a high-risk pregnancy.		
Trigger	The event that would indicate when this decision-support logic should appear within the workflow, such as the activity that would trigger this decision to be made.		
Inputs	**Output**	**Action**	**Annotations**
These are the variables or conditions that need to be considered to determine the consequent actions or outputs » If there are multiple input entries on the **same** row, these different inputs are considered as "AND" – conditions that need to be in place at the same time » Inputs placed on different rows are considered as "OR" conditions that can be considered independently of the inputs on other rows.	The resulting action or decision based on the combination of input entries. This is the statement that immediately follows the "THEN". Examples of outputs may include a diagnosis, alerts/prompts for referral, and counselling.	Concrete measures to be taken based on the output (refer, provide treatment and/or counselling, conduct test, etc.). In some cases, output and action may be the same.	Additional explanations or descriptions, including possible pop-up alert messages and relevant background information. This section can also include the written content which would appear in the pop-up messages notifying the health worker on the appropriate next steps, which can include counselling, case management approach, or referral.

DBP: diastolic blood pressure; SBP: systolic blood pressure.

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

Table 12. Example decision-logic table for hypertension counselling

Below is an excerpt from an elaborated decision-support table using an example from ANC. All the decision-support tables referenced above in the overview table (*Table 10*) are available in the *Web Annex B*.

Decision ID	ANC.DT.16 Pre-eclampsia, severe pre-eclampsia and hypertension diagnosis					
Business Rule	If the woman presents with any of the following symptoms and/or test results, conduct counselling and referral as needed					
Trigger	ANC.B10.4. Diagnosis and treatment					
Inputs				**Output**	**Action**	**Annotations**
140 mmHg ≤ "Systolic blood pressure" < 160 mmHg	140 mmHg ≤ "Repeat systolic blood pressure" < 160 mmHg	"Symptoms of severe pre-eclampsia" = "No symptoms of severe pre-eclampsia"	"Urine dipstick result – protein" = "++"	"Pre-eclampsia" = TRUE	Refer urgently to a hospital	Pre-eclampsia diagnosis! Refer to hospital and revise birth plan. Woman has pre-eclampsia – SBP of 140 mmHg or above and/or DBP of 90 mmHg or above and proteinuria 2+ and no symptom of severe pre-eclampsia.

Procedure:
– Refer to hospital
– Revise the birth plan |
90 mmHg ≤ "Diastolic blood pressure" < 110 mmHg	90 mmHg ≤ "Repeat diastolic blood pressure" < 110 mmHg	"Symptoms of severe pre-eclampsia" = "No symptoms of severe pre-eclampsia"	"Urine dipstick result – protein" = "++"	"Pre-eclampsia" = TRUE	Refer urgently to a hospital	
140 mmHg ≤ "Systolic blood pressure" < 160 mmHg	140 mmHg ≤ "Repeat systolic blood pressure" < 160 mmHg	"Symptoms of severe pre-eclampsia" = "No symptoms of severe pre-eclampsia"	"Urine dipstick result – protein" = "+++"	"Pre-eclampsia" = TRUE	Refer urgently to a hospital	
90 mmHg ≤ "Diastolic blood pressure" < 110 mmHg	90 mmHg ≤ "Repeat diastolic blood pressure" < 110 mmHg	"Symptoms of severe pre-eclampsia" = "No symptoms of severe pre-eclampsia"	"Urine dipstick result – protein" = "+++"	"Pre-eclampsia" = TRUE	Refer urgently to a hospital	

6.3 Decision trees

Decision trees may be used to supplement the structured format of the decision-support tables and can help in visualizing different pathways. The addition of decision trees may be especially useful for decision points that consist of multiple inputs and outputs. Examples of decision trees are given in Fig. 11.

Fig. 11. Examples of decision trees to supplement decision-support tables
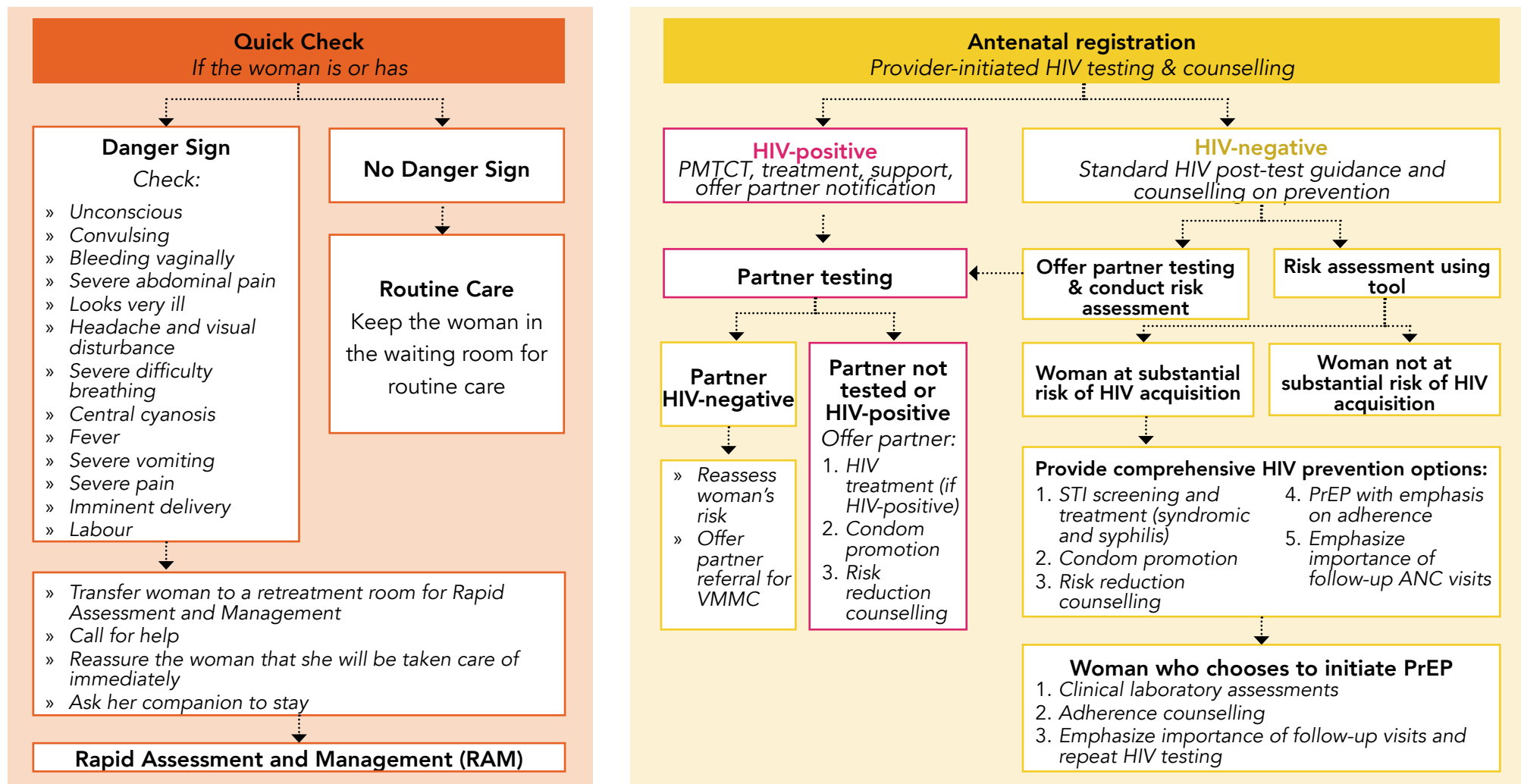
ANC: antenatal care; PMTCT: prevention of mother-to-child transmission; PrEP: pre-exposure prophylaxis; STI: sexually transmitted infection; VMMC: voluntary medical male circumcision.

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

6.4 Scheduling logic overview

In addition to specific decision-support logic that needs to be detailed, there is also scheduling logic to facilitate the digital tracking of clients and ensure that appropriate services are provided in a timely manner according to clinical protocols. For example, it will be important for the health worker to know when the client's next contact is due based on the recommendations for eight scheduled contacts throughout the course of the pregnancy. In the case of ANC, there is a need to map out the schedules for upcoming contacts, immunizations and lab tests. Table 13 provides an overview of the different schedule logic tables included in this digital adaptation kit. The details within each scheduling logic are elaborated in *Web Annex B*.

Table 13. Overview of scheduling logic

Scheduling logic ID	Scheduling logic name	Description	Reference(s)
ANC.S.01	**ANC contact schedule**	Recommended ANC contact schedule	WHO ANC recommendations (2016) *(8)*
ANC.S.02	**ANC lab and tests schedule**	Recommended schedule for conducting laboratory tests and imaging if those tests are recommended or required	WHO ANC recommendations (2016): B.1.1, B.1.2, B.1.7, B.1.8 *(8)* WHO syphilis guideline for pregnant women (2017) *(32)* WHO syphilis PMTCT (IMPAC) (2007) *(42)*
ANC.S.03	**Counselling schedule**	Recommended schedule for counselling recommended during pregnancy	WHO ANC recommendations (2016) *(8)* WHO syphilis guideline for pregnant women (2017) *(32)* WHO syphilis PMTCT (IMPAC) (2007) *(42)* Guidelines on hepatitis B and C testing (2017) *(31)* WHO recommendations on health promotion interventions (2015) *(39)* Medical eligibility criteria for contraceptive use (2015) *(38)* WHO pre-eclampsia and eclampsia recommendations (2011) *(34)*
ANC.S.04	**Immunization schedule**	Recommended schedule for immunizations that are recommended during pregnancy	Vaccines against influenza position paper (2012) *(35)* WHO ANC recommendations (2016): C.5 *(8)*
ANC.S.05	**Malaria prophylaxis schedule**	Recommended schedule for malaria prophylaxis recommended during pregnancy	WHO ANC recommendations (2016): C.6 *(8)*

World Health Organization

Component **7** Indicators and performance metrics
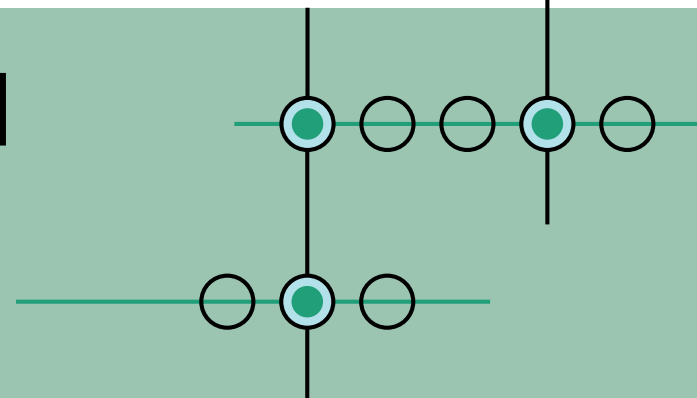
This section details indicators and performance metrics that would be aggregated from core data elements identified in *Component 5*. These indicators are based on the WHO ANC monitoring framework *(43)* and the WHO–UNICEF guidance for RMNCAH programme managers on the analysis and use of health-care facility data *(18)*. These indicators may be aggregated automatically from the digital tracking tool to populate a digital HMIS, such as DHIS2. This table is also available in *Web Annex C*.

Table 14. Indicators and performance metrics

Indicator code	Indicator name	Numerator		Denominator		Disaggregation	Reference
		Definition	Computation	Definition	Computation		
ANC.IND.1	**Percentage of pregnant women with first ANC contact in the first trimester (before 12 weeks of gestation)**	Number of pregnant women who had their first ANC contact before 12 weeks (facility level)	COUNT of women whose gestational age ≤ 12 weeks at the time of first contact	Total number of antenatal clients with a first contact	COUNT of all women who had first contact within the last reporting period	Age (10–14, 15–19, 20+) Education level (none, don't know, primary, secondary, higher)	WHO ANC monitoring framework *(43)* WHO–UNICEF guidance for RMNCAH programme managers on the analysis and use of health-care facility data *(18)*

Indicator code	Indicator name	Numerator		Denominator		Disaggregation	Reference
		Definition	Computation	Definition	Computation		
ANC.IND.2	Percentage of pregnant women who received iron and folic acid (IFA) supplements for 90+ days	Number of pregnant women who received the recommended number of IFA tablets during all previous contacts	COUNT of number of women who were prescribed IFA tablets at each ANC contact they have had	Total number of antenatal clients with a first contact	COUNT of all women whose records were closed (ANC close form) in the last reporting period due to any of the reasons below: » live birth » stillbirth » miscarriage » abortion » woman died » lost to follow-up » moved away	Age (10–14, 15–19, 20+) Education level (none, don't know, primary, secondary, higher)	WHO ANC monitoring framework (43)
ANC.IND.3	Percentage of pregnant women screened for syphilis during ANC	Number of pregnant women screened for syphilis	COUNT of number of women who had at least one syphilis test result recorded during pregnancy	Total number of antenatal clients with a first contact	COUNT of all women whose records were closed (ANC close form) in the last reporting period due to any of the reasons below: » live birth » stillbirth » miscarriage » abortion » woman died » lost to follow-up » moved away	Age (10–14, 15–19, 20+) Education level (none, don't know, primary, secondary, higher) Contact number categories (Contact number categories:* 1, 2–3, 4–8, 9+) *If the woman had multiple syphilis tests done during pregnancy, use the contact number of the first test result recorded	WHO ANC monitoring framework (43) WHO–UNICEF guidance for RMNCAH programme managers on the analysis and use of health-care facility data (18)
ANC.IND.4	Percentage of pregnant women with at least four ANC contacts	Number of pregnant women with four ANC contacts	COUNT of all women who had a total of at least FOUR contacts during pregnancy	Total number of antenatal clients with a first contact	COUNT of all women whose records were closed (ANC close form) in the last calendar month due to any of the reasons below: » live birth » stillbirth » miscarriage » abortion » woman died » lost to follow-up » moved away	Age (10–14, 15–19, 20+) Education level (none, don't know, primary, secondary, higher)	WHO ANC monitoring framework (43) WHO–UNICEF guidance for RMNCAH programme managers on the analysis and use of health-care facility data (18)

Digital Adaptation Kit for Antenatal Care

World Health Organization

Indicator code	Indicator name	Numerator		Denominator		Disaggregation	Reference
		Definition	Computation	Definition	Computation		
ANC.IND.5	**Percentage of pregnant women with a minimum of eight antenatal care contacts**	Number of pregnant women with eight ANC contacts	COUNT of all women who had a total of EIGHT OR MORE contacts during pregnancy	Total number of pregnant women with a first contact	COUNT of all women whose records were closed (ANC close form) in the last calendar month due to any of the reasons below: » live birth » stillbirth » miscarriage » abortion » woman died » lost to follow-up » moved away	Age (10–14, 15–19, 20+) Education level (none, don't know, primary, secondary, higher)	WHO ANC monitoring framework (43) WHO–UNICEF guidance for RMNCAH programme managers on the analysis and use of health-care facility data (18)
ANC.IND.6	**Pregnant women who received counselling on danger signs (%) during at least one ANC contact**	Number of pregnant women who received counselling on danger signs	COUNT of all women who received counselling on danger signs	Total number of pregnant women with a first contact	COUNT of all women whose records were closed (ANC close form) in the last calendar month due to any of the reasons below: » live birth » stillbirth » miscarriage » abortion » woman died » lost to follow-up » moved away	Age (10–14, 15–19, 20+) Education level (none, don't know, primary, secondary, higher)	WHO ANC monitoring framework (43)
ANC.IND.7	**Percentage of pregnant women with at least one blood pressure measure during ANC**	Number of antenatal clients with blood pressure measured	COUNT of all women who had their blood pressure measured at least once during pregnancy	Total number of antenatal clients with a first contact	COUNT of all women whose records were closed (ANC close form) in the last calendar month due to any of the reasons below: » live birth » stillbirth » miscarriage » abortion » woman died » lost to follow-up » moved away	Age (10–14, 15–19, 20+) Education level (none, don't know, primary, secondary, higher) Trimester categories: » 1st (GA ≤ 12 weeks); » 2nd (GA > 12 weeks to ≤ 28 weeks); » 3rd (GA > 28 weeks)	WHO ANC monitoring framework (43) WHO–UNICEF guidance for RMNCAH programme managers on the analysis and use of health facility data (18)

Indicator code	Indicator name	Numerator		Denominator		Disaggregation	Reference
		Definition	Computation	Definition	Computation		
ANC.IND.8	Percentage of pregnant women with at least one blood pressure measure in the third trimester during ANC	Number of pregnant women with blood pressure measurement in third trimester	COUNT of all women who had their blood pressure measured at least once during their third trimester	Total number of antenatal clients with a first contact	COUNT of all women whose records were closed (ANC close form) in the last calendar month due to any of the reasons below: » live birth » stillbirth » miscarriage » abortion » woman died » lost to follow-up » moved away	Age (10–14, 15–19, 20+) Education level (none, don't know, primary, secondary, higher)	WHO ANC monitoring framework *(43)*
ANC.IND.9	Percentage of pregnant women whose baby's heartbeat was listened to at least once during ANC	Number of pregnant women whose baby's heartbeat was listened to	COUNT of all women who had their baby's heartbeat listened to at least once during pregnancy	Total number of antenatal clients with a first contact	COUNT of all women whose records were closed (ANC close form) in the last calendar month due to any of the reasons below: » live birth » stillbirth » miscarriage » abortion » woman died » lost to follow-up » moved away	Age (10–14, 15–19, 20+) Education level (none, don't know, primary, secondary, higher) Trimester categories: » 1st (GA ≤ 12 weeks); » 2nd (GA > 12 weeks to ≤ 28 weeks); » 3rd (GA > 28 weeks)	WHO ANC monitoring framework *(43)*
ANC.IND.10	Percentage of pregnant women with an ultrasound scan before 24 weeks	Number of pregnant women who received ultrasound scan before 24 weeks	COUNT of all women who had an ultrasound scan done before 24 weeks gestational age	Total number of antenatal clients with gestational age equal to 24 weeks	COUNT of all pregnant women who reached 24 weeks gestational age in the past calendar month	Age (10–14, 15–19, 20+) Education level (none, don't know, primary, secondary, higher)	WHO ANC monitoring framework *(43)*

Digital Adaptation Kit for Antenatal Care

World Health Organization

Indicator code	Indicator name	Numerator		Denominator		Disaggregation	Reference
		Definition	Computation	Definition	Computation		
Context-specific indicators							
ANC.IND.11	**Percentage of women who received three doses or more of intermittent preventive therapy for malaria (IPTp) during their last pregnancy**	Number of pregnant women given at least three doses of sulfadoxine–pyrimethamine for IPTp	COUNT of all women who received a third dose of sulfadoxine–pyrimethamine for IPTp	Total number of antenatal clients with a first contact	COUNT of all women whose records were closed (ANC close form) in the last calendar month due to any of the reasons below: » live birth » stillbirth » miscarriage » abortion » woman died » lost to follow-up » moved away	Age (10–14, 15–19, 20+) Education level (none, don't know, primary, secondary, higher)	WHO ANC monitoring framework (43) WHO–UNICEF guidance for RMNCAH programme managers on the analysis and use of health-care facility data (18)
ANC.IND.12	**Percentage of pregnant women counselled and tested for HIV**	Number of pregnant women attending ANC who received counselling and testing for HIV during pregnancy	COUNT of all women who received provider-initiated counselling and testing (PICT)	Total number of antenatal clients with a first contact	COUNT of all women whose records were closed (ANC close form) in the last calendar month due to any of the reasons below: » live birth » stillbirth » miscarriage » abortion » woman died » lost to follow-up » moved away	Age (10–14, 15–19, 20+) Education level (none, don't know, primary, secondary, higher)	WHO ANC monitoring framework (43) WHO–UNICEF guidance for RMNCAH programme managers on the analysis and use of health-care facility data (18)
ANC.IND.13	**Percentage of pregnant women who received oral pre-exposure prophylaxis (PrEP)**	Number of pregnant women attending ANC who received counselling and testing for HIV during pregnancy	COUNT of all women who received oral PrEP	Total number of antenatal clients with a first contact	COUNT of all women whose records were closed (ANC close form) in the last calendar month due to any of the reasons below: » live birth » stillbirth » miscarriage » abortion » woman died » lost to follow-up » moved away	Age (10–14, 15–19, 20+) Education level (none, don't know, primary, secondary, higher)	WHO ANC monitoring framework (43)

ANC: antenatal care; GA: gestational age; RMNCAH: reproductive, maternal, newborn, child and adolescent health.

Indicators and performance metrics

Component 8 # High-level functional and non-functional requirements

This section provides an overview of illustrative functional and non-functional requirements that may be considered to kick-start the process of designing or adapting the digital tracking and decision-support system. Functional requirements describe the capabilities the system must have in order to meet the end-users' needs and achieve tasks within the business process. Non-functional requirements provide the general attributes and features of the digital system to ensure usability and overcome technical and physical constraints. Examples of non-functional requirements include ability to work offline, multiple language settings and password protection.

Table 15 highlights some key functional requirements for executing the business processes listed in *Component 4* of this document, and the complete set of functional requirements can be accessed in *Web Annex D*. *Table 16* provides non-functional requirements as general characteristics of the overall system. Please note that these are not exhaustive lists and should be modified according to context and user persona needs.

8.1 Functional requirements

Table 15. Functional requirements[a]

Requirement ID	Activity ID and description	As a…	I want…
Business process A: Registration			
ANC.FXNREQ.001	Rapid assessment and management (RAM)	Health worker or clerk	To bypass the standard flow at any point if an urgent case is identified
ANC.FXNREQ.002	Search for client[b] name and record	Health worker or clerk	To search to see whether client is already in the system (using at least 2 identifiers)
ANC.FXNREQ.003	Search for client name and record	Health worker or clerk	The system to display sufficient data to identify the client
ANC.FXNREQ.004	Search for client name and record	Health worker or clerk	The system to require me (a user) to search to see whether a client is already in the system prior to starting a new medical record entry
ANC.FXNREQ.005	Search for client name and record	Health worker or clerk	To use client identification system (e.g. QR code, bar-code, fingerprint) and pull-up patient information

Digital Adaptation Kit for Antenatal Care

Requirement ID	Activity ID and description	As a...	I want...
ANC.FXNREQ.006	Search for client name and record	Health worker or clerk	To provide sufficient data to rule out the possibility that this client is already in the system
ANC.FXNREQ.007	Create client record	Health worker or clerk	To be able to enter identification information
ANC.FXNREQ.008	Create client record	Health worker or clerk	The system to indicate mandatory fields that must be filled out for registration to be valid
ANC.FXNREQ.009	Create client record	Health worker or clerk	To generate encounter number for contact
ANC.FXNREQ.010	Create client record	Health worker or clerk	To generate or associate to existing facility medical record number
ANC.FXNREQ.011	Create client record	Health worker or clerk	To edit fields on screen before information is committed
ANC.FXNREQ.012	Create client record	Health worker or clerk	To enter a temporary identification in emergency situations when full identity unknown
ANC.FXNREQ.013	Validate client details	Health worker or clerk	To display client information for validation (and be able to edit it)
ANC.FXNREQ.014	Validate client details	Health worker or clerk	To be able to update demographic information
ANC.FXNREQ.015	Validate client details	Health worker or clerk	To retain previous history of updated information
ANC.FXNREQ.016	Validate client details	Health worker or clerk	To be able to attach an identifier (e.g. QR code, bar-code, fingerprint, photo) to the client's record based on national standards consent
ANC.FXNREQ.017	Validate client details	Health worker or clerk	To be able to confirm client identity
ANC.FXNREQ.018	Validate client details	Health worker or clerk	If this is a returning contact, to add the information to their previous contact
ANC.FXNREQ.019	Check in client	Health worker or clerk	To record a time-and-date-stamped new contact (encounter)
Business process B: ANC Contact			
ANC.FXNREQ.020	Registration	Health worker or clerk	See functional requirements above for registration (Business process A)
ANC.FXNREQ.021	Rapid assessment and management (RAM)	Health worker or clerk	To bypass the standard flow at any point if an urgent case is identified; and to flag urgent cases to be seen promptly
ANC.FXNREQ.022	Pregnancy confirmed	Health worker	To document the pregnancy
ANC.FXNREQ.023	Pregnancy confirmed	Health worker	To calculate gestational age (based on last menstrual period [LMP])
ANC.FXNREQ.024	Quick check	Health worker or clerk	To indicate the woman has arrived for first contact, scheduled contact or a specific health concern (tasks will vary based on health worker roles)
ANC.FXNREQ.025	Quick check	Health worker	To identify symptoms and signs that may require medical attention
ANC.FXNREQ.026	Quick check	Health worker	To determine whether to manage woman in-facility or refer
ANC.FXNREQ.027	Collect woman's profile and history	Health worker	The system to provide a standardized form for the entry of ANC profiles
ANC.FXNREQ.028	Collect woman's profile and history	Health worker	To provide identification information for woman based on data entered
ANC.FXNREQ.029	Collect woman's profile and history	Health worker	To print a copy of the ANC information that replicates the paper antenatal register
ANC.FXNREQ.030	ANC assessment	Health worker	The system to provide a standardized form for the entry of clinical data
ANC.FXNREQ.031	ANC assessment	Health worker	The system to provide real-time range checks and integrity checks on data
ANC.FXNREQ.032	ANC assessment	Health worker	To review past medical history previously entered

High-level functional and non-functional requirements

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

Requirement ID	Activity ID and description	As a...	I want...
ANC.FXNREQ.033	ANC assessment	Health worker	A list of tests that I (the health worker) can order
ANC.FXNREQ.034	ANC assessment	Health worker	To print a requisition for lab tests, which includes required information for performing the test
ANC.FXNREQ.035	ANC assessment	Health worker	To provide decision support as appropriate for users based on data entered
ANC.FXNREQ.036	ANC assessment	Health worker	The system to suggest appropriate treatments/investigations based on data entered
ANC.FXNREQ.037	ANC assessment	Health worker	The system to highlight abnormal values
ANC.FXNREQ.038	Counselling, in-facility management and treatment	Health worker	The system to provide context-sensitive, real-time decision support in response to entry of clinical data (alerts, advice, resources)
ANC.FXNREQ.039	Counselling, in-facility management and treatment	Health worker	To provide decision support as appropriate for users based on data entered
ANC.FXNREQ.040	Counselling, in-facility management and treatment	Health worker	To provide context-specific information in response to the entry of clinical data
ANC.FXNREQ.041	Referral	Health worker	See functional requirements above for referral (Business process C)
ANC.FXNREQ.042	Scheduling	Health worker	To see a schedule of available days
ANC.FXNREQ.043	Scheduling	Health worker	To be able to input custom schedules to allow for contacts on specific days and times, account for holidays, etc.
ANC.FXNREQ.044	Scheduling	Health worker	To display number of existing contacts per day (to allow for balancing)
ANC.FXNREQ.045	Scheduling	Health worker	To indicate (based on protocol) the preferred days for follow-up contact
ANC.FXNREQ.046	Scheduling	Health worker	To record identification and tracking information (e.g. mobile phone number) for patient in schedule
ANC.FXNREQ.047	Scheduling	Health worker or clerk	A list or roster of all antenatal women
ANC.FXNREQ.048	Scheduling	Health worker or clerk	Tools to search, sort and filter the antenatal database
ANC.FXNREQ.049	Self-care intervention in the home or community	Woman	Access to accurate health information accessible and appropriate for lay persons (this may include both "pull" and "push" options)c
ANC.FXNREQ.050	Self-care intervention in the home or community	Woman	To receive information messages in a way that ensures my confidentiality
ANC.FXNREQ.051	Woman returns	Health worker	A list of scheduled contacts to allow for defaulters to be traced
ANC.FXNREQ.052	Woman returns	Health worker	The ability to "check in" a woman for a scheduled contact
ANC.FXNREQ.053	Woman returns	Health worker	To identify the date of the last attended contact

a Business processes C and D are available in the full spreadsheet of "ANC functional and non-functional requirements".

b The term "client" is used for the registration workflow as this is applicable to other health domains, and "women" is used for the ANC-specific business processes.

c The forthcoming self-care interventions DAK will describe the requirements for client-facing digital tools that will access health information.

Digital Adaptation Kit for Antenatal Care

World Health Organization

8.2 Non-functional requirements

Table 16. Non-functional requirements

Requirement ID	Category	Non-functional requirement
ANC.NFXNREQ.001	Security – confidentiality	Provide password-protected access for authorized users
ANC.NFXNREQ.002	Security – confidentiality	Provide a means to ensure confidentiality and privacy of personal health information
ANC.NFXNREQ.003	Security – confidentiality	Provide ability for allowed users to view confidential data
ANC.NFXNREQ.004	Security – confidentiality	Anonymize data that is exported from the system
ANC.NFXNREQ.005	Security – confidentiality	Prevent remembering username and password
ANC.NFXNREQ.006	Security – confidentiality	Automatically log out the user after specified time of inactivity
ANC.NFXNREQ.007	Security – confidentiality	Provide encrypted communication between components
ANC.NFXNREQ.008	Security – authentication	Notify the user to change their password the first time they log in
ANC.NFXNREQ.009	Security – authentication	Adhere to complex password requirements
ANC.NFXNREQ.010	Security – authentication	Provide a mechanism to securely change a user's password
ANC.NFXNREQ.011	Security – authentication	Notify the user of password change to their account
ANC.NFXNREQ.012	Security – authentication	Reset a user's password in a secure manner
ANC.NFXNREQ.013	Security – authentication	Lock a user out after a specified number of wrong password attempts
ANC.NFXNREQ.014	Security – authentication	Notify a user if their account is locked due to wrong password attempts
ANC.NFXNREQ.015	Security – authentication	Provide role-based access to the system
ANC.NFXNREQ.016	Security – audit trail and logs	Log system logins and logouts
ANC.NFXNREQ.017	Security – audit trail and logs	Record all authentication violations
ANC.NFXNREQ.018	Security – audit trail and logs	Log all activities performed by the user, including date-and-time stamp
ANC.NFXNREQ.019	Security – audit trail and logs	Log access to views of individual client records
ANC.NFXNREQ.020	Security – audit trail and logs	Log access to data summaries, reports, analysis and visualization features
ANC.NFXNREQ.021	Security – audit trail and logs	Log exchange of data with other systems
ANC.NFXNREQ.022	Security – audit trail and logs	Generate analysis of the usage of different system features and reports
ANC.NFXNREQ.023	Security – audit trail and logs	Log all data and system errors
ANC.NFXNREQ.024	Security – user management	Allow user with permission to create a new user and temporary password
ANC.NFXNREQ.025	Security – user management	Provide role-based access
ANC.NFXNREQ.026	Security – user management	Allow roles to be associated with specific geographical areas and/or health-care facilities

Requirement ID	Category	Non-functional requirement
ANC.NFXNREQ.027	Security – user management	Allow cascading user management and assignment of roles
ANC.NFXNREQ.028	Security – user management	Allow user to change their own password
ANC.NFXNREQ.029	Security – user management	Allow admin user to request password reset
ANC.NFXNREQ.030	Security – user management	Notify the user to regularly change their password
ANC.NFXNREQ.031	Security – user management	Allow each user to be assigned to one or more roles
ANC.NFXNREQ.032	Security – user management	Support definitions of unlimited roles and assigned levels of access, viewing, entry, editing and auditing
ANC.NFXNREQ.033	System requirements – general	Provide a unique version number for each revision
ANC.NFXNREQ.034	System requirements – general	Enable earlier versions of a record to be recoverable
ANC.NFXNREQ.035	System requirements – general	Enable deployment in an environment subject to power loss
ANC.NFXNREQ.036	System requirements – general	Work in an environment that is subject to loss of connectivity
ANC.NFXNREQ.037	System requirements – general	Generate IDs that are unique across different installations or sites
ANC.NFXNREQ.038	System requirements – general	Report version number when saving data to the database
ANC.NFXNREQ.039	System requirements – general	Be designed to be flexible enough to accommodate necessary changes in the future
ANC.NFXNREQ.040	System requirements – general	Allow for offline and online functionality
ANC.NFXNREQ.041	System requirements – general	Show the number of records that are not yet synchronized
ANC.NFXNREQ.042	System requirements – general	Have ability to easily back up information
ANC.NFXNREQ.043	System requirements – general	Warn user if no valid backup for more than a predefined number of days
ANC.NFXNREQ.044	System requirements – general	Must have the ability to store images and other unstructured data
ANC.NFXNREQ.045	System requirements – scalability	Scalable to accommodate new demands
ANC.NFXNREQ.046	System requirements – scalability	Be able to accommodate at least [x number of] health-care facilities
ANC.NFXNREQ.047	System requirements – scalability	Be able to accommodate at least [x number of] concurrent users
ANC.NFXNREQ.048	System requirements – usability	Be user-friendly for people with low computer literacy
ANC.NFXNREQ.049	System requirements – usability	Provide informative error messages and tool-tips
ANC.NFXNREQ.050	System requirements – usability	Alert the user when navigating away from a form without saving
ANC.NFXNREQ.051	System requirements – usability	Support real-time data-entry validation and feedback to prevent data-entry errors from being recorded
ANC.NFXNREQ.052	System requirements – usability	Simplify data recording through predefined drop-down menu or searchable lists, radio buttons, check boxes
ANC.NFXNREQ.053	System requirements – usability	Support multiple languages
ANC.NFXNREQ.054	System requirements – usability	Use industry standard user interface practices and apply them consistently throughout the system
ANC.NFXNREQ.055	System requirements – usability	Easy to learn and intuitive to enable user to navigate between pages

Digital Adaptation Kit for Antenatal Care

World Health Organization

Requirement ID	Category	Non-functional requirement
ANC.NFXNREQ.056	System requirements – usability	Provide guidance to users to better support clinical guidelines and best clinical practices
ANC.NFXNREQ.057	System requirements – usability	Be reliable and robust (minimize the number of system crashes)
ANC.NFXNREQ.058	System requirements – usability	Adjust display to fit small screens (e.g. mobile phones)
ANC.NFXNREQ.059	System requirements – configuration	Configure the system centrally
ANC.NFXNREQ.060	System requirements – configuration	Configure business rules in line with guidelines and standard operating procedures (SOPs)
ANC.NFXNREQ.061	System requirements – configuration	Configure error messages
ANC.NFXNREQ.062	System requirements – configuration	Configure workflows and business rules to accommodate differences between facilities
ANC.NFXNREQ.063	System requirements – interoperability	Communicate with external systems through mediators
ANC.NFXNREQ.064	System requirements – interoperability	Provide access to data through application programming interfaces (APIs)
ANC.NFXNREQ.065	System requirements – interoperability	Link with insurance systems to verify eligibility and submit claims
ANC.NFXNREQ.066	System requirements – interoperability	Exchange data with other approved systems
ANC.NFXNREQ.067	System requirements – interoperability	Accept data from multiple input methods including paper, geocoding (GPS)
ANC.NFXNREQ.068	System requirements – interoperability	Communicate with external systems through mediators
ANC.NFXNREQ.069	System requirements – hardware and connectivity	Allow for data exchange and efficient synchronization across multiple facilities and points of service when Internet is available, even when it is intermittent and slow

RECOMMENDATIONS
PERSONAS
SCENARIOS
WORKFLOWS
DATA
DECISIONS
INDICATORS
REQUIREMENTS

Glossary

Note: Terms in definitions also defined in this glossary shown in italics.
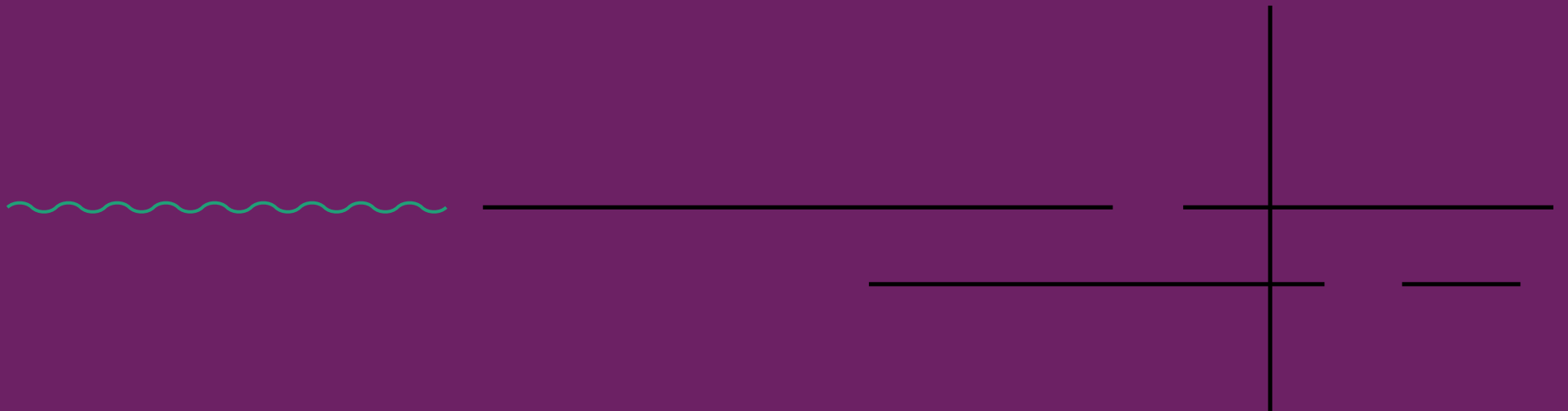
Business process	A set of related activities or *tasks* performed together to achieve the objectives of the health programme area, such as registration, counselling, referrals *(1,15)*.
Data dictionary	A centralized repository of information about the *data elements* that contains their definition, relationships, origin, usage, and type of data. For this digital adaptation kit, the data dictionary is provided as a spreadsheet.
Data element	A unit of data that has specific and precise meaning.
Decision-support logic	A set of decision rules for standard and exceptional cases that is separate from the *business process*. This would help reduce the complexity of the *business process* depiction without losing the detail necessary for coding the rules required for system functionality.
Decision support (for health workers)	Digitized job aids that combine an individual's health information with the health worker's knowledge and clinical protocols to assist health workers in making diagnosis and treatment decisions *(9)*.
Decision-support table	Decision-support tables are a semi-structured way to depict each discrete decision that will need to be embedded in the system. Depending on the complexity of the clinical guidelines, there will likely be multiple decision-support tables.
Digital health	The systematic application of information and communications technologies, computer science and data to support informed decision-making by individuals, the health-care workforce and health systems, to strengthen resilience to disease and improve health and wellness *(44)*.
Digital tracking	The use of a digitized record to capture and store clients' health information to enable follow-up of their health status and services received. This may include digital forms of paper-based registers and case management logs within specific target populations, as well as electronic medical records linked to uniquely identified individuals *(9)*.
Functional requirement	Capabilities the system must have in order to meet the end-users' needs and achieve tasks within the *business process*.
Health information system (HIS)	A system that integrates data collection, processing, reporting and use of the information necessary for improving health service effectiveness and efficiency through better management at all levels of health services *(45)*.
Health management information system	An information system specifically designed to assist in the management and planning of health programmes, as opposed to delivery of care *(45)*.

Digital Adaptation Kit for Antenatal Care

World Health Organization

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Interoperability	The ability of different applications to access, exchange, integrate and use data in a coordinated manner through the use of shared application interfaces and standards, within and across organizational, regional and national boundaries, to provide timely and seamless portability of information and optimize health outcomes.
Non-functional requirement	General attributes and features of the digital system to ensure usability and overcome technical and physical constraints. Examples of non-functional requirements include ability to work offline, multiple language settings, and password protection.
Persona	A generic aggregate description of a person involved in or benefitting from a health programme.
Standard	In software, a standard is a specification used in digital application development that has been established, approved and published by an authoritative organization. These rules allow information to be shared and processed in a uniform, consistent manner independent of a particular application.
Task	A specific action in a *business process*.
Terminologies	For clinical care, terminologies are structured vocabularies covering health-related concepts – such as diseases, diagnoses, laboratory tests and treatments – to enable the storage, analysis and exchange of data in a consistent and standard way *(46,47)*.
Workflow	A visual representation of the progression of activities (tasks, events, decision points) in a logical flow illustrating the interactions within the *business process (16)*.

RECOMMENDATIONS

PERSONAS

SCENARIOS

WORKFLOWS

DATA

DECISIONS

INDICATORS

REQUIREMENTS

Annexes

ANNEX 1. Examples of detailed persona

Example 1: Dative, skilled midwife, 26 years old, speaks Kinyarwanda and English

Dative, Skilled midwife, 26 Years old, speaks Kinyarwanda and English
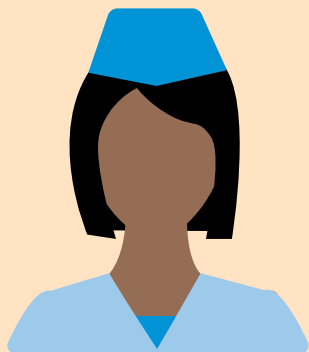
MY TASKS

Clinical tasks
- Receiving and orienting women in ANC
- ANC consultations
- Lab exams

Other tasks
- Filling registers **(6 per each ANC day)**
- Providing reports

My Typical Day

07h00: Receiving clients(Women and their partners), request them to fill their Insurance Papers

07h30: Counselling on 4 standards visits of ANC, Family Planning, Nutrition,…

08h30: Taking Lab exams , VAT Vaccination, ANC Consultation by standard visit

13h00: Break

14h00: Giving results to clients

15h30: Closing, daily reporting, pointage

We fill too many registers which is time consuming and creates a high turn around time

My workplace
- The health center is located in Muhima Sector and attached to Muhima hospital and serves 21588 people in its catchment area
- At ANC visit day, we receive 15 to 20 couples
- There is 1 nurse who works with me at each ANC day
- There is a computer for our service, there is internet connection in our health facility.

Challenges encountered working on ANC services

PAPERWORK
- Repetition of activities (registration same information in each service like Names, DOB, Gender….)
- No medical history
- No report from Agent de Santé Maternelle

Support to other services

Sometimes we are requested so support other services, such as vaccinations

Workload

It is heavy because the number of clients who come and service packages that I have to deliver to them is beyond my capacity.

Stock out

We sometimes have stock out for Folic Acid(Fer) caused by the stockout on district pharmacy level and we ask our clients to find them in private pharmacies.

Digital Adaptation Kit for Antenatal Care

World Health Organization

Example 2: Ahmla, village nurse midwife, Indonesia
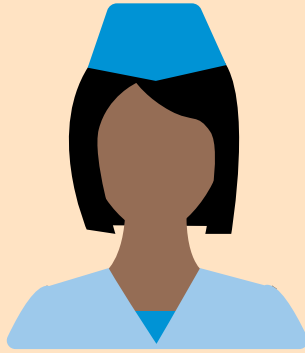
Work

- » Bulk of time spent running clinic (posyandu), attending births and writing reports
- » Proud of her position and impact
- » Relies on help from other cadres (kaders) to do things such as enter data, enter information, fetch clients and organize queues during clinic
- » Seems well organized
- » Takes own initiative to improve health in her community (she installed electricity at her own *polindes* [mobile clinic for maternal and child health and family planning] to have during deliveries)
- » Skill level among midwives (*bidan*) can vary, according to midwife coordinator; not all midwives are as good as Ahmla (similar situation in India)

Facts and demographics

- » Underwent formal education and internship
- » Organizes monthly clinic (*posyandu*) in each hamlet
- » Responsible for 24 hamlets
- » Leads ANC and health for children aged 0–1 with vaccination and nutrition nurses
- » Enters data into paper registers (individual, community) and completes monthly report forms that include indicator targets (from district health office)
- » Good technology skills – smartphone, some social media
- » Gets financial incentive for every delivery attended
- » Area has 200 pregnancies a year (Ahmla will attend up to 180); compounded by many happening at the same time of year

Needs and goals

- » Needs fewer cases (all her time seems to be clinics and attending deliveries; she cannot possibly do this during "rush season")
- » Sometimes role conflicts with *dukun bayi* (traditional unskilled birth attendant); non-involvement of midwife (*bidan*) may be due to lack of desire, education or awareness [on the part of the pregnant woman]
- » Wants more leverage to convince families [of the value of having a trained and skilled midwife]
- » Wants dependable supplies
- » Finds tracking people and service difficult sometimes, especially if outside of the local health system

ANNEX 2. Guidance adding or amending data elements to the data dictionary

When adapting the data dictionary, data elements may be needed to be modified or added due to existing paper registers or local reporting requirements. If starting from paper-based registers and forms, you can find additional guidance in the *Handbook for digitizing primary health care (17)* and below is an overview of the data mapping excerpt to provide a template for standardizing the data dictionary. When amending wording of data elements, it is important to ensure that the standard terminology codes still reflect the data element as originally intended.

What to note	Description
Activity ID	The ID number of the task in the workflow in which the data element is collected. This will denote which point in time at which this data element is collected. This should align with the Activity ID that is provided in Form Mapping.
Data element code	Each data element should have an identification number or code that is unique across the entire project. Use existing serial or identification numbers when available. If no identifiers exist, fields should be enumerated in a logical format.
Form ID and form data element label	The Form ID should be from the ID listed. List the Form ID in which the data element appears. This is important for ensuring that the design of the digital system has taken into account all the required paper forms and data elements on those paper forms. Also list the label of the data element as written in the original form (or translated as closely as possible). This will be key in keeping track of which data elements from the original paper forms are duplicated. Note that duplicate data fields can be included purposely (patient identifiers, such as name, date of birth, village, ID number, etc. would be included in multiple data instruments as a means to identify an individual patient).
Data element label	The label of the data element written in a way in which the end-users can easily understand, e.g. "education level", "weight", "height", "reasons for coming into facility", "which medication(s) is your client taking?" The data element label in this column is what will be used in the digital form. The digital register should not simply replace the paper registers, but it should also streamline processes and link duplicated data elements; thus the data element label listed here should be what will be used in the digital system.
Data element name	The shorthand name for the data element (e.g. "educ_level" for "education level"; "weight_kg" for "weight"; "height_m" for "height"). This will be key when coding the system and determining calculations required. This data element name is what will reconcile any duplicate data elements in the digital system.
Description and definition	The description of the data field, including any units that define the field (e.g. "weight in kilograms (kg)"). Provide a clear explanation of what this data point is requesting, assuming the reader has never seen the form. Be sure to use consistent and easy-to-understand terminology across all forms. This is particularly important if the data element name differs across forms but requires the same input.

Digital Adaptation Kit for Antenatal Care

World Health Organization

What to note	Description
Data type	The data type should be aligned with data types outlined by Fast Health Interoperability Resources (FHIR) standards. Some common data types are: » Boolean (e.g. True/False, Yes/No) » String (a sequence of Unicode characters, e.g. name) » Date (e.g. date of birth) » Time (e.g. time of delivery) » ID (e.g. unique identifier assigned to the client) » Integer (a whole number, e.g. number of past pregnancies) » Decimal (rational numbers that have a decimal representation, e.g. exact duration of time, location coordinates, all percentages) » Observation (health status observations collected from the client, e.g. height, weight, eye colour, pulse, blood pressure, temperature, glucose level) » Codeable concept (a value that is usually supplied by providing a reference to one or more data points, e.g. body mass index, contraceptive prevalence rate) » Signature (an electronic representation of a signature that is either cryptographic or a graphical image that represents a signature or a signature process, e.g. supervisor's approval) » Attachment (additional data content defined in other formats, e.g. images) » Note that if there are multiple choice data fields, the "parent" data field should be labelled "Multiple choice – Select one" or "Multiple choice – Select all that apply". Then each individual option should listed in the "Input" options column and be classified with one of the data types listed above. Although the list above should be sufficient to relay this information to a health informaticist or technology vendor, there are many more data codes that can be applied to achieve a more precise classification. For other possible data types, please refer to the HL7 FHIR guide on data types *(48)*.
Input options	For multiple choice fields only; otherwise leave this column blank. Write the list of responses from which the health worker may select. Each of these input options should be in a separate row and reference the parent Data ID in its own Data ID (e.g. [Parent data element ID].[Option number]). Each of these options should be labelled with a data type as indicated above.
Calculation	For "codeable concept" data type fields, write the formula that defines the field. Leave this column blank for all other data types. Use standard mathematical symbols and the data element label of the data element names included in the formula (e.g. for the body mass index (BMI) calculation, "weight_kg/([height_m]^2)")
Validation required	"**Yes**" or "**No**" to indicate whether there needs to be some form of validation given the constraints provided by a range of acceptable responses.
Validation condition	The range of acceptable responses, if validation is required (e.g. for a phone number, only 10 digits allowed; for a birthday, only past dates allowed).
Editable	"**Yes**" or "**No**" to indicate whether the end-user, or health worker, would be able to edit the field after it has been input to the system.
Required	Note whether or not this field is: » Required – **R** » Required, but can be left empty – **RE** » Optional – **O** » Conditional on answers from other data fields – **C** » Conditional, but can be left empty – **CE**

What to note	Description
Reason for required data	If this field is required (**R**), state the reason here – whether for: » Accountability for national-level reporting » Service delivery or clinical decision-making » Client identification The digital system should not simply replace your paper registers, but it should also streamline processes; thus, it is important to understand why a certain data field is actually required and seek opportunities to optimize data flows. Given the high volume of data collection required of health service providers, it might be better to remove a data entry field if it serves no real purpose for the clinician, public health reporting, or any other identified purpose.
Skip logic	If this field is conditional on answers from other data fields (**C**) or conditional, but can be left empty (**CE**), denote what the skip logic is here. This is common for data elements that are a part of follow-up questions. If the input of one data element field has a value lower than a certain threshold, then some data inputs can be skipped. Those data elements will have skip logic that is defined by a pre-set threshold.
Linked to aggregate indicator	Aggregate indicators should be called out and specified. **If this data element is linked to an aggregate indicator**, then indicate "**Yes**" here. If not, indicate "**No**".
Notes	If there is an issue or inconsistency in how a data field is defined, make a note of the issue here. Irregularities and inconsistencies will need to be resolved at a later stage through a process of team discussion and triangulation. This column should also be used for any other notes, annotations, or communication messages within the team.
Concept mappings	Depending on which systems you plan on interoperating with, other columns will most likely need to be added to map to the concepts used in the other system (e.g. ICD-11, SNOMED). One column should be used for each concept dictionary.

Digital Adaptation Kit for Antenatal Care

World Health Organization

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