Digital civil registration and vital statistics systems: principles; functional requirements; licensing, service and hosting options; and procurement considerations

Practitioners' guide

November 2024

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Summary

The present guide was developed as a resource for country stakeholders, civil registration and vital statistics agencies, including those involved in decision-making on the digitalization of the civil registration and vital statistics system, and local and international experts providing technical and policy guidance about the design or adoption of digital solutions to enhance civil registration and vital statistics systems.

In the guide, the notion of "digitalization" is understood as the use of digital technologies to replace paper-based civil registration and vital statistics systems, which involves the re-engineering of business processes, simplification of operations, provision of online services and general enhancement of user experiences.

The guide is structured in five chapters:

a. **Chapter I: Principles for the design and implementation of digital civil registration and vital statistics systems.** This chapter comprises a discussion of the guiding principles that support the optimal performance of civil registration and vital statistics systems, enabling the systems to achieve the fundamental purpose of universal registration of vital events and the production of vital statistics in line with United Nations principles, standards and recommendations;

b. **Chapter II: Key functional and non-functional requirements of digital civil registration and vital statistics systems**. In this chapter, insights are provided to the key functional and non-functional requirements of digital approaches to civil registration and vital statistics, in alignment with United Nations standards;

c. **Chapter III: Licensing of digital civil registration and vital statistics systems and their benefits and risks.** This chapter sets out various options for licensing: it is crucial that the appropriate source code licensing model be selected, while weighing the related benefits and risks;

d. **Chapter IV: Hosting options.** The fourth section highlights the different service and hosting options for digital civil registration and vital statistics systems and their benefits and risks, indicating why it is essential to conduct a thorough analysis to select the most appropriate hosting option;

e. **Chapter V: Procurement considerations**. The last chapter sets out the requirements for the procurement of information and communications technology (ICT) for civil registration and vital statistics systems, along with critical questions to be considered when assessing the specific digital equipment to be procured for civil registration and vital statistics.

Introduction

The management of civil registration and vital statistics systems is an essential function of Governments. By recording vital events such as births and deaths in a country and issuing legal documents pertaining to these events, citizens and residents gain access to basic rights and services. Civil registration records and the resulting vital statistics enable Governments and the private sector to develop effective public policies and programmes and to streamline governance processes.

Information and communications technology (ICT) is critical to the creation of well-functioning and inclusive civil registration and vital statistics systems. Digital approaches will enhance the key functions of a civil registration system, which are to collect, store, retrieve, transmit, protect and manage vital event data within a defined jurisdiction. Digitalization will render civil registration and vital statistics processes simpler and more efficient, economical, accessible and transparent. At the same time, if the digital procedures are not well designed and are not aligned with key recommended principles and features of operations (including those outlined by the United Nations), the performance of a civil registration and vital statistics system may be obstructed and the privacy of personal data may be jeopardized, thereby infringing the fundamental rights of individuals and even having a detrimental impact on a country's governance processes.

A. Human rights and digitalization

The digitalization of civil registration and vital statistics systems may have a positive impact on the exercise of human rights. Digitalization has the potential to improve access to and the efficiency of civil registration services and products, hence enhancing the Government's capacity to ensure that individuals' right to a name and nationality[1] and other related rights are duly upheld. It must be emphasized, however, that digitalization should not be an end in itself. A human-centred approach must be adopted to ensure that the design of the digitalization of civil registration and vital statistics systems is guided by individuals' and families' needs and rights.

Since the sharing and interoperability of data are critical for enhancing civil registration and vital statistics processes, privacy and data protection regulations should be strengthened to ensure that the digitalization of those systems is fully aligned with human rights principles.

B. Concept of digitalization

In the present guide, the notion of "digitalization" is understood as the use of digital technologies to replace paper-based civil registration and vital statistics systems, which involves the re-engineering of business processes, simplification of operations, provision of online services and general enhancement of user experiences. Digitalization therefore goes beyond the mere conversion of analog data into digital format. That process is referred to as "digitization", and it comprises the work of converting the analog information found in books and archives into a digital form in databases which can be stored, processed and transmitted using digital technology. This process involves the use of digital devices and software to capture, store and manipulate data.

1 While civil registration records and documents provide important biographical information that is needed to prove nationality, civil registration does not in itself confer nationality.

When planning a digitalization project, it is essential to consider whether digital records will fully replace paper records or not. This is a legal question with enormous practical implications. The introduction of digital technology in civil registries does not necessarily entail the elimination of paper usage. Paper may still be necessary for specific procedures, in particular the issuance of physical certificates or the registration of the vital event itself.

In advanced stages of digitalization, the civil registration and vital statistics digital system should ensure the authenticity and integrity of digital records, for which a system known as public key infrastructure[2] is required. Public key infrastructure, also referred to as PKI, describes the tools used to create and manage public keys for encryption, which is a common method of securing data transfers on the Internet and which makes it possible to adopt use of electronic signatures and digital certification.

C. General guidance about civil registration and vital statistics digitalization projects

Prior to initiating any digitalization efforts or choosing a digital platform to adopt, a country should undertake a holistic assessment[3] of its civil registration and vital statistics systems to determine the extent to which the current system is achieving its objectives, including the identification of any performance issues or bottlenecks in current registration processes. Such an assessment will help to identify strategic actions to be undertaken for further development of the system and to determine the potential for the use of technology.

Actions to address key bottlenecks such as weaknesses in legislation, organization, management and infrastructure issues; human resources; weak business processes; and others need to be prioritized prior to embarking on a digitalization project. The digital approach should be viewed as a tool to facilitate or enhance attainment of the objectives of the civil registration and vital statistics improvement efforts rather than the system itself. Digitalizing inefficient processes can result in further inefficiencies and wastage of resources. It is therefore important that the digitalization exercise be a mere component of a broader civil registration and vital statistics improvement exercise and be aligned with the vision and strategic objectives of the civil registration and vital statistics system as a whole.

D. About this document

1. Objectives and target audience

The present document, a practitioners' guide, has been developed to serve as a resource for country stakeholders, including those that are involved in decision-making in obtaining IT assets for CRVS systems, and local and international experts providing technical and policy guidance about the design or adoption of digital approaches to enhance civil registration and vital statistics systems.

The guide complements and should be read and used alongside the *Civil Registration and Vital Statistics Digitization Guidebook* issued under the Africa Programme on Accelerated Improve-

2 For more information, see https://www.okta.com/identity-101/public-key-infrastructure/.

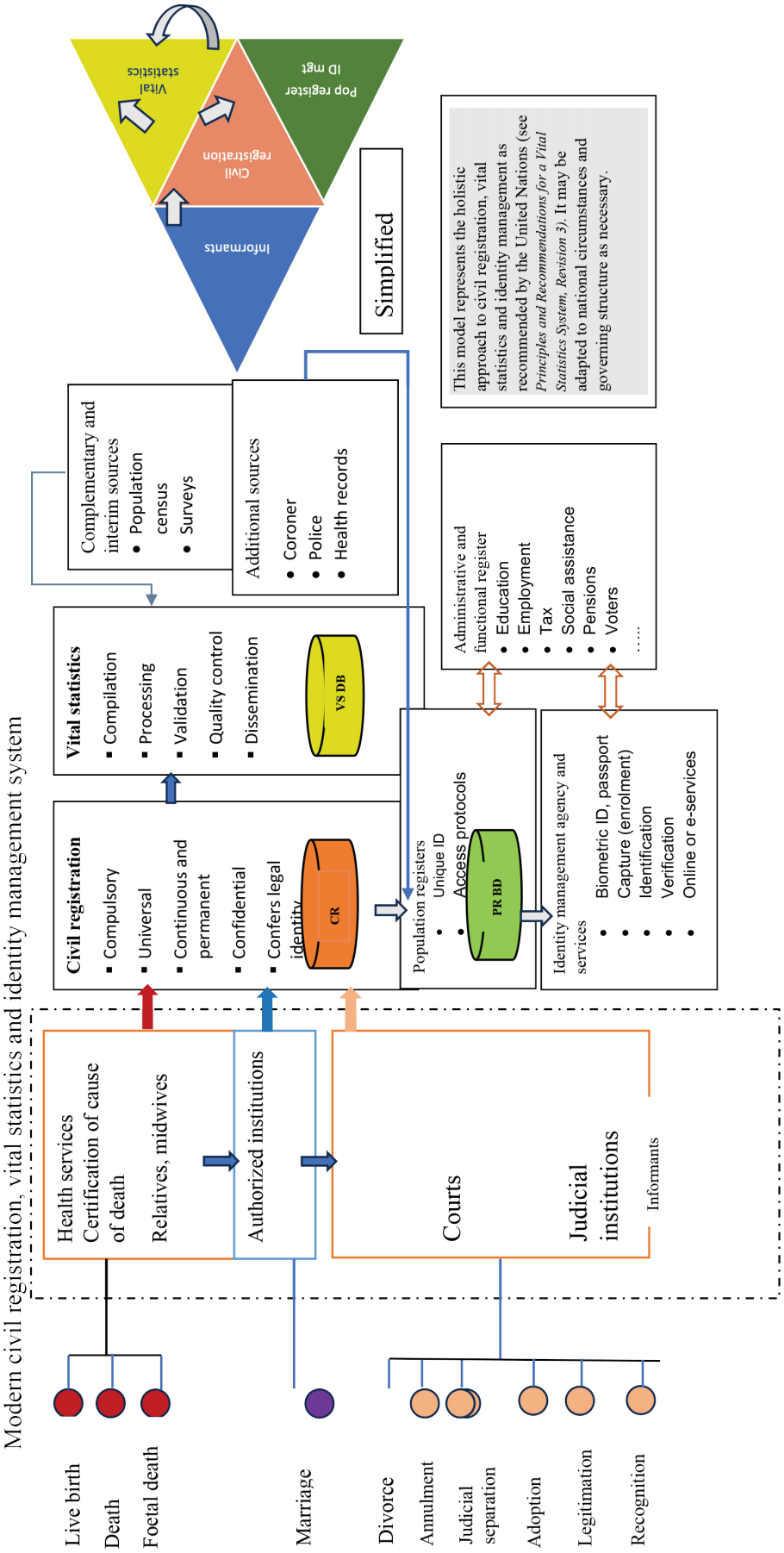
3 For further details, see the ***CRVS Systems Improvement Framework***, available at https://getinthepicture.org/resource/crvs-systems-improvement-framework.

ment of Civil Registration and Vital Statistics Systems,[4] which provides comprehensive step-by-step and end-to-end guidance on how to undertake a civil registration and vital statistics digitalization project. Specifically, the guide provides information to complement sections 7 and 8 of the aforementioned *Civil Registration and Vital Statistics Digitization Guidebook*, which provide guidance on defining the target system architecture and the respective system requirements.

2. Scope

While the present guide focuses on key principles for the design and implementation of digital approaches to civil registration and vital statistics, it is recognized that there are important linkages that civil registration and vital statistics systems should have with other ICT platforms within the Government, such as the population register, the health information system, the voter registry and the national identification system, among others. It is therefore essential that the ICT system that is adopted be highly interoperable and support the United Nations integrated approach to health, civil registration, vital statistics and identity management, as demonstrated in the figure below.

4 Available at http://www.crvs-dgb.org/en/.



Abbreviations: CR DB, civil registration database; ID, identity card; PR DB, population registers database; VS DB, vital statistics database.\

The overall goal of this resource is to support countries in the implementation of sustainable, reliable, stable and secure ICT systems for civil registration and vital statistics that facilitate the establishment, verification and authentication of legal identity in compliance with national legislation and international standards and the production of timely and reliable vital statistics.

I. Principles for the design and implementation of digital civil registration and vital statistics systems

The principles of a system are the general rules and guidelines that inform and support its objectives. The guiding principles for the design and implementation of digital systems for civil registration and vital statistics are guidelines that support the optimal performance of the system, hence enabling it to achieve its fundamental purpose of the universal registration of vital events and the production of vital statistics in line with United Nations principles, standards and recommendations, and also to pursue other associated goals.

The eight principles set forth in the present guide were initially developed by the member countries and territories of the Pacific Community during the Pacific regional workshop on legal identity and identity security, held in July 2019 at the Community's headquarters, and revised by African member States and experts of the Africa Programme on Accelerated Improvement of Civil Registration and Vital Statistics Systems digitalization group.

The principles can help guide countries to adopt robust governance practices and consistent technological design options in their engagement with ICT system vendors and other relevant stakeholders.

The order in the list below does not imply relevance or hierarchy and the principles are all interdependent in nature.

A. Principle 1: Compliance with national and international legal frameworks and standards

1. Description

The implementation of digital civil registration and vital statistics system should comply with international principles and standards for civil registration and vital statistics,[5] national legislation including any existing statutory instruments on civil registration and ICT, legislation or policy on such issues as privacy, security, data-sharing, auditing and digital government, and relevant international treaties.

2. Rationale

All other principles and requirements are secondary to delivering a system that complies with international principles and standards on civil registration and vital statistics, the country's specific legislative framework and relevant international treaties.

3. Implications

Documentation on the design and procurement of ICT systems for civil registration and vital statistics should explicitly state how they will ensure compliance with existing legislation and standards, at both national and international levels.

5 See, for example, the Handbook on Civil Registration and Vital Statistics Systems: Management, Operation and Maintenance, Revision 1, available at https://unstats.un.org/unsd/demographic-social/Standards-and-Methods/files/Handbooks/crvs/crvs-mgt-E.pdf.

B. Principle 2: Sustainability

1. Description

An ICT system for civil registration and vital statistics should be sustainable over the long term in the following ways:

a. **Technical:** support staff to systematically maintain the system, since the ICT system will need to be regularly updated, constantly improved and monitored;

b. **Instructional:** Registry and technical support staff should maintain adequate knowledge to manage the ICT system effectively;

c. **Administrative:** Relevant support contracts and service agreements should be in place for the life of the ICT system; and

d. **Financial:** Funds should be secured to cover all costs associated with the ICT system for its expected lifetime.

To the extent possible, countries should adopt a long-term approach and aim to consider these factors as important drivers of sustainability.

It is imperative that a sustainability plan be developed alongside the ICT system. Such a plan should incorporate a knowledge-transfer component and outline modalities for its operationalization to ensure that the country is in possession of all the knowledge, information and skills necessary to maintain the system.

2. Rationale

An ICT system for civil registration and vital statistics is a long-term investment for a country. As such, it is imperative to put in place adequate mechanisms to ensure that the various components of the system are sustained over their intended lifetime.

3. Implications

The technical, instructional, administrative and financial sustainability of the ICT system, along with the sustainability of any other areas crucial to its long-term operation, should be addressed explicitly during the planning, procurement and design phases. Care should be taken when the implementation phase is complete and the system is handed over so that its maintenance forms part of routine operations. Adequate budgets must be assigned to provide for any maintenance and upgrades required over the expected lifetime of the ICT system. In identifying or developing the digital system of choice which enables sustainability, countries should refrain from disproportionate front-loaded investments and rather adopt phase-based or incremental improvement approaches with sustained investments.

C. Principle 3: Design-based cybersecurity, data protection, and privacy

1. Description

The integration of privacy considerations from the outset into technology, ICT systems, services and products ensures that data protection is prioritized alongside other functionalities. ICT systems for civil registration and vital statistics should explicitly address cybersecurity,

data protection and privacy standards at all stages of the project lifecycle. Relevant considerations that should be made include ensuring best practices in end-user cybersecurity testing, disaster management, user management (e.g. deactivation of user login after a specified number of unsuccessful login attempts, password expiration, strong passwords enforcement, login monitoring), role-based access control, multi-factor authentication, backup systems, data encryption at rest and in transit, active audit log monitoring and alerting, vulnerability monitoring, regular security scanning and penetration testing, disaster mitigation, management and recovery, third party vendor assessment and compliance, and constant updates or policies in such areas as minimization, purpose specification and transparency regarding how data are shared.

2. Rationale

ICT systems for civil registration and vital statistics include significant amounts of personal data which make them attractive targets to malicious actors. Accordingly, data security, including in the context of disasters, data protection and privacy are important considerations in the selection and design of any ICT systems. Data protection standards should be embedded in the design and development process and in operations to build trust with users and stakeholders, reduce the risk of data breaches and more effectively comply with privacy regulations. Securing the data that the ICT systems hold from unauthorized disclosure or modification and respecting the privacy of the persons to whom the data pertain are critical to establishing and maintaining the trust of all stakeholders in the systems.

3. Implications

A formal risk assessment should be carried out as part of the ICT system development. Security requirements should be identified at the same time as functional requirements and should be explicitly included in tender documentation. ICT systems with strong cybersecurity, data protection and privacy characteristics should be prioritized. The architects of ICT systems for civil registration and vital statistics should explicitly state how they will deliver on security requirements and which cybersecurity standards they apply. Plans should be developed to keep the cybersecurity, data protection and privacy measures of the system up to date for its lifetime.

D. Principle 4: Interoperability and data-sharing

1. Description

To harness the full potential of the legal identity data stored in the civil registry, ICT systems should be able to share data with other government agencies within a country and regionally, as appropriate, in accordance with the legal mandate.

While actual data-sharing will depend on the regulations and agreements of a particular country, the ICT system for civil registration and vital statistics should have the capability to facilitate secure and easy data-sharing – both automatically and manually – with other organizations entitled to those data. That capability should allow for the easy configuration of the key restrictions attached to any data-sharing agreement, such as the ability to share only certain types of records. Specific data standards should be defined for data structure and semantics applicable to the stakeholders in the civil registration and vital statistics system and within the associated ICT system in order to ensure interoperability with key sectors such as health, education, social protection and others. In addition, application programming

interfaces, also known as APIs, are essential to ensuring secure interoperability with internal or external services for various clients.

2. Rationale

Civil registration data are vital to the processes performed by private stakeholders, such as opening bank accounts, claiming insurance payments and others, and providers of government services, including social protection, identity management, provision of passports, conduct of elections, health and education services and vital statistics production. This capability becomes more important with the development of digital government (e-Government) services and the integration of civil registration as a fundamental component of digital public infrastructure. Data-sharing between countries for such purposes as the management of cross-border migration or linking of events occurring in different countries may also be a motivating factor to improve the performance of civil registration and vital statistics systems. Overall, interoperability ensures the breakdown of system silos and support for other government functions to the expected standard.

3. Implications

ICT systems should support modern data-sharing protocols and the ability to comply with data-sharing agreements if countries decide to share data internally and regionally. Data-sharing should be easily configurable by civil registration and vital statistics teams and require as little ICT expertise as possible. Civil registration and vital statistics systems should support multiple mechanisms of data exchange to allow for the differing capabilities of partner organizations or systems. Defining and publicizing data standards are essential to interoperability. All data-sharing arrangements should be backed by technical documentation detailing who should be granted access to the data and providing a robust data protection mechanism that ensures transparency for citizens about the nature of the data and how they are shared.

E. Principle 5: Appropriateness to country context

1. Description

The functional requirements of an ICT system for civil registration and vital statistics should be customized to the country context and ideally not require a more extensive ICT infrastructure, skill sets or capability for implementation or ongoing maintenance than can reasonably be supplied within a national context for the expected lifespan of the system. Where possible, it is strongly recommended that countries[6] adopt a gradual strategy for the scaling up and development of ICT capacities within the staff of the civil registration organization and other government institutions to ensure autonomy and avoid vendor lock-in for the expected lifespan of the system.

2. Rationale

Countries may have few skilled ICT specialists available within their Government and the private sector. In other cases, the number of such specialists may be insufficient to handle the existing workload, leading to significant difficulties in maintaining complex applications systems over the lifetime of the ICT system for civil registration and vital statistics. In this regard, it is pertinent that the ICT system is appropriate to the national context. In addition,

6 Except for very small countries that do not have the capacity to maintain a team of their own.

it is necessary to continually develop the ICT capacities of staff to ensure sustainability in maintaining ICT systems over their lifetime.

3. Implications

Implementation of an ICT system for civil registration and vital statistics should include planning to address capability and knowledge, with a view to filling the skill gaps in the country. Countries may consider outsourcing or using the cloud-based delivery service model known as "software as a service", at least in the initial phase, with a longer-term plan to build local capacity in ICT-related competencies (hosting, system design, data analytics configuration and others). Countries could consider local partnerships with incubation hubs, universities and other institutions of knowledge development and learning, and private companies, as part of public-private partnerships, to address the capability gaps.

F. Principle 6: Design in collaboration with and for the benefit of the user

1. Description

ICT systems of civil registration and vital statistics should be developed in collaboration with, and with critical consideration of the needs of, the direct and indirect users, beneficiaries and overall stakeholders of the system. These include, for example, personnel managing civil registration functions, front-line civil registrars, officials dealing with the production of vital statistics, members of the public and users of civil registration records or data within other government ministries or departments as provided for under the law.

2. Rationale

The various stakeholders of the ICT system for civil registration and vital statistics have differing user needs which should all be well documented and accounted for during the system's design.

3. Implications

The conduct of a thorough stakeholder and user needs analysis is pertinent and a priority for the digitalization project. The information derived from the analysis should be used to guide the design of the digital system. Furthermore, it is crucial to exhaustively test the designs with users in every social and physical context in order to achieve the widest possible inclusion of those users and to ensure that adequate consideration is given to their specific needs. In all cases, the digital civil registration and vital statistics solution should respond to user needs.

G. Principle 7: Country data ownership

1. Description

Civil registration and vital statistics data must be owned by the country, and the ICT system should fully respect the country's sovereignty.

2. Rationale

Civil registration data are regarded as nationally significant for a variety of reasons, enabling countries or other jurisdictions to exercise their sovereignty, and the data often have significant cultural, historical or even monetary value.

3. Implications

During the procurement process, country ownership of data must be explicit in any agreement or contract. Contracts should explain how and in what format countries can obtain their data in the event that a commercial arrangement with a vendor comes to an end or the vendor ceases to operate. Jurisdictional questions about data must be addressed explicitly in the case of cloud-based systems or the software-as-a-service approach. Contracts must identify the data to which vendors have access and which uses of those data (if any) vendors are permitted to have. Ideally, the source code should be available to the civil registration and vital statistics organization as well.

H. Principle 8: Adaptability

1. Description

ICT systems for civil registration and vital statistics should be adaptable in their design, so as to handle changes in civil registration and vital statistics processes and government priorities and to respond to ongoing technological changes. This should include allowing direct customization by the administrative user of general functionalities, such as user management, reporting, graphic design and others, without the need for these to be specifically identified for the ICT staff or the provider as new features of the system.

2. Rationale

An ICT system for civil registration and vital statistics is a long-term investment for a country. As such, it should be able to handle the types of changes that can occur over its lifetime. In addition, the differences between countries are significant and any such system that seeks to support multiple countries should be designed with those differences in mind.

3. Implications

During the processes of procurement or design, it should be made clear how the ICT system can manage changes in requirements over its lifetime. Systems that can incorporate change without expensive code modifications (e.g. through configuration) should be favoured.

II. Key functional and non-functional requirements of digital civil registration and vital statistics systems

The United Nations has set out international guidelines and standards on civil registration and vital statistics systems,[7] including key features of such systems and the way in which they should be organized and managed to enable them to effectively perform their functions and yield the expected outputs. The present chapter discusses key functional and non-functional requirements of digital systems for civil registration and vital statistics in line with United Nations standards.[8] The functional and non-functional requirements listed here are not in any particular order.

A. Functional requirements of digital civil registration and vital statistics systems

Functional requirements relate to the operation and functionalities of the system in accordance with the usage requirements, namely, how users are expected to interact with the system and its functionalities, and the desired outcomes. Functional requirements refer to the specifications of the software, namely, what precisely the software is intended to do (the goals of the software). If it fails to meet these requirements, the civil registration and vital statistics system will not perform its functions effectively and therefore not yield its expected outputs. The requirements outlined are aligned with the United Nations principles and standards for civil registration and vital statistics that form the basis of widely recognized good practice.

1. Functional requirement 1: Capacity to register all vital events

(a) Description

The United Nations outlines 10 vital events that should be registered compulsorily by a civil registration organization: live births, deaths, foetal deaths, adoptions, legitimations, recognitions, judicial separations, marriages, civil partnerships and divorces. Live births, deaths and foetal deaths are recognized as high priority events and, thus, recommended for priority civil registration by all countries. An ICT system for civil registration and vital statistics should have the capacity to register all vital events and enable the collection of cause-of-death information in accordance with international standards.

(b) Rationale

While the civil registration law in a country may not require registration of all 10 vital events at the time of design or implementation, as the civil registration and vital statistics system and its related subsidiary systems evolve, the ability to register the other events should be anticipated. The ICT system for civil registration and vital statistics should therefore facilitate

7 Available at https://unstats.un.org/unsd/demographic-social/crvs/index.%20cshtml#method.

8 A more comprehensive outline of functional and non-functional requirements for digital civil registration and vital statistics systems is available in the United Nations Children's Fund publication: "CRVS platforms: key findings for practitioners", available at https://unstats.un.org/legal-identity-agenda/documents/Paper/CRVS_Key%20Findings_for_Practitioners.pdf.

the inclusion of all events without requiring major structural adjustments or financial investments.

(c) Implications

Irrespective of the vital events that a country currently registers, the ICT system for civil registration and vital statistics should be able to add other event types as needs arise, employing a modular approach. It should be possible initially to turn off the functionality for registering these other events, with the option of reactivating it when required.

2. Functional requirement 2: Inclusion of all civil registration and vital statistics milestones

(a) Description

The digital system should facilitate the processing of all milestones of a civil registration process, including the production of vital statistics.[9] These milestones include notification; validation and verification; certification; information-sharing; storage and archiving; compilation of vital statistics; quality control of vital statistics; generation of vital statistics; and dissemination of vital statistics.

(b) Rationale

The full value to a country of civil registration is best realized when all the milestones and all the necessary functions of the ICT system are captured. While the digital system may not in itself manage the processes for the compilation and generation of vital statistics, it facilitates their production and the necessary sharing of data for the national statistical office responsible for the production of the vital statistics report.

(c) Implications

The ICT system for civil registration and vital statistics should be so designed as to facilitate automation of all milestones. Where the notification and verification of vital events are concerned, the adoption of dual and separate sources of information and evidence (e.g. validation against the health sector data and the identity system) is recommended to ensure authenticity of the vital events.

3. Functional requirement 3: Linkage of related records (person-centred approach)

(a) Description

ICT systems for civil registration and vital statistics should be person-centred: all vital events related to an individual (e.g. birth, death, divorce, marriage and so forth) should be linked. In addition, relationships between individuals should also be captured, such as the individual's spouse for a marriage, parents for a birth and children.

9 Daniel Cobos, Carla Abouzhar and Don de Savigny (2018). The 'Ten CRVS Milestones' framework for understanding Civil Registration and Vital Statistics systems. BMJ Global Health, 2018, vol. 3. Available at https://gh.bmj.com/content/bmjgh/3/2/e000673.full.pdf.

(b) Rationale

An improved understanding of which records relate to a particular individual will enhance the ability of civil registrars to maintain the integrity and consistency of data and will facilitate various applications of civil registration data, such as their use as in the development of a population register, supporting digital government processes, etc.

(c) Implications

ICT systems with person-centred approaches should be prioritized. The use of record numbers and unique personal identifiers facilitates the identification of individuals' records within the system and enables the creation of personal profiles and the linkage of related personal records. In this process, protocols for data confidentiality must be observed.

4. Functional requirement 4: Detection, merging and removal of duplicate records

(a) Description

The entry of more than one record for the same event should be automatically detected, the registrar notified and the duplicate record removed. The removal of potential duplicate records requires a policy and guidelines setting out the key processes.

(b) Rationale

There is an inherent risk that civil registration and vital statistics systems may include more than one record for the same event. This can happen as a consequence of fraud and also inadvertently, such as when event registration is undertaken from different localities or at different points in time or when there is a slight alteration of the details of an event resulting in an event appearing as not previously registered. A well-designed matching function, feature or algorithm will enable the database to be searched for any matching records and, if found, will prompt for confirmation of the data.

(c) Implications

The ICT system for civil registration and vital statistics should include standard rules and checks applied to each record accepted into the database to detect any duplicates (whether entered by external, third-party systems, by civil registration representatives in regional centres, or by staff at the central civil registration office). If a potential duplicate match is found, it should be brought to the attention of the relevant civil registration and vital statistics staff member and resolved appropriately.

5. Functional requirement 5: Querying and record searches

(a) Description

Users need to be able to search and retrieve records from the ICT system for civil registration and vital statistics, using a variety of parameters (e.g. single names, multiple names, diacritics, transliterations, previous names used, geographical locations, date ranges, contact details and others).

(b) Rationale

The ability to search for recent and historical records should be a basic functionality of an ICT system for civil registration and vital statistics. Civil registration offices are often requested to facilitate a genealogical search of records by individuals, families, courts and researchers.

(c) Implications

The ICT system should enable the effective and efficient searching of current and historical records, including corrections and amendments. It is important to leverage name-search algorithms that consider phonetic matching; name-language identification; typographical errors and misspellings; orthographical variations; initials matching; optional name tokens and other features. It should also enable easy retrieval of any associated supporting documents.

6. Functional requirement 6: Correction and amendment of records

(a) Description

It should be possible to modify civil registration records to reflect amendments to, and to record recent changes in, the civil status of an individual.

(b) Rationale

Civil registration records are dynamic and may require correction or changes, such as the addition of details of a father, new documents in cases of adoption, legal name changes, corrections of erroneous information and annotations to the records.

(c) Implications

The ICT system for civil registration and vital statistics should have the capacity to facilitate the recording of corrections and amendments to civil registration records, without tampering with the original record. All amendments should be logged in the ICT system with relevant metadata (e.g. information identifying who changed the record, when it was changed and any supporting documents for the change, as applicable).

7. Functional requirement 7: Certificate management

(a) Description

Users should be able to print all required certificates, based on defined templates. The system should keep records of all certificates printed and provide a reliable means of verification of the certificate, as a fraud prevention and audit measure.

(b) Rationale

The keeping of unique records of individual certificates, and also of the life events that they certify, will make it possible to verify documents and can help in the detection and prevention of identity fraud or other abuses.

(c) Implications

Each instance of a printed certificate should be verifiable. The inclusion of a unique number, a quick response (QR) code or a bar code will enable tracing and auditability. Certificates should have version numbering to manage changes over the life of an individual (e.g. for amendments and corrections) and to be verifiable. Certificate records should be searchable on the basis of certificate identifiers and version numbers. The printing function may need to be able to manage secure paper for certain certificate types. The use of a validation feature, however, such as a QR code or bar code – which removes the need for security paper – may be considered, as this will save costs and provide an efficient and secure way to verify the authenticity of certificates.

8. Functional requirement 8: Activity logging capacity

(a) Description

The system must log all user actions; any action taken by a user within the system – whether to open, create, update or delete a record – must be recorded in a log. Each log entry should include what the action was, who made it, when and what was changed, for example, by capturing the record both before and after an action was taken to modify the record. The log must be protected against illegal manipulations.

(b) Rationale

This function enables the active and retrospective auditing of the systems and system users, and the discovery and investigation of security breaches – whether by unauthorized individuals or authorized individuals acting in breach of policy – and assists in the investigation of incidents. It also provides assurance in demonstrating compliance with privacy and data protection laws and policies.

(c) Implications

It is recommended that three levels of logs, namely, access log, process log and audit log, be enabled and that these logs form a permanently recorded part of the civil registration and vital statistics system, in line with user activity. The access log enables the documentation of records consulted for enquiry or update purposes. The process log develops a history of all processes employed by all users in the system. The audit log maintains a permanent history of all changes made to any record in the system.

All logs are to be made available to system administrators and high-level civil registry staff for enquiry purposes. It is recommended that an alert function be put in place and directed at the civil registration and vital statistics management team to enable active monitoring. Access to the logs should be restricted and the logs should be protected from tampering. The system should have the ability to run reports of login activities.

9. Functional requirement 9: Interoperability (allowing for the import and export of data)

(a) Description

The system should adopt interoperable standards to exchange data with other external platforms. Interoperability is an essential characteristic of civil registration and vital statistics

applications because it facilitates communication and data-sharing among sectors that need to interact electronically with the civil registration and vital statistics system, such as the health sector, the identity management system and statistics offices, and also potentially with private sector users and across borders.

(b) Rationale

Data need to be imported to and exporting from the system for various purposes, namely, for data-processing (e.g. to ingest data from the health system such as birth records or to compare data of two individuals in respect of whom record duplication is suspected) and data-sharing (e.g. to provide relevant data to another government sector). A common requirement of a civil registration office is to provide regular – and ad hoc – datasets to approved recipients, such as the identity management system, the national statistical office, health departments, electoral commissions, education departments and approved private organizations.

The ICT system for civil registration and vital statistics should be able to accept individual records from other systems, such as the health information system, as applicable, according to the local process for civil registration. Bulk data-importing – in cases in which data cannot be directly entered into the ICT system, for example, owing to a power outage, or in cases where historical data previously stored in other formats need to be imported – is also an important functionality for an ICT system.

(c) Implications

Countries should ensure that any technical platform under consideration has the relevant functionality – namely, that it is currently required and envisaged for the future – to receive and share data from external platforms.

10. Functional requirement 10: Role-based user permission

(a) Description

An ICT system for civil registration and vital statistics should define which users have access to which functions and categories of data. That access should be assigned to the role that an individual holds within the civil registration and vital statistics system, rather than to the individual. For example, a "deputy-registrar" role should be created, and a number of permissions assigned to that role. Subsequently, all deputy registrars can be assigned that role and automatically gain related privileges.

(b) Rationale

A civil registration office employs staff with various responsibilities. Users should only have permissions within the ICT system to perform actions and have access to records to which they are entitled by virtue of their roles. This will help to prevent people from performing unauthorized actions, while enabling others to perform the actions pursuant upon their role. The role-based user permission functionality facilitates the management of permissions and helps to prevent the emergence of issues such as permission creep or over-provisioning of permissions.

(c) Implications

Each user must have a unique username and password. Shared user accounts or usernames must not be allowed. User roles should be created to manage system permissions. Permissions should not be attached directly to user accounts. All user accounts must be associated with roles that reflect the functions and data to which they require access to perform their duties. Roles and individual assignments to roles should be regularly audited to ensure that access is limited to those requiring it.

11. Functional requirement 11: Storage and backup

(a) Description

Civil registration datasets must be adequately maintained to facilitate their retrieval over extended periods of time. The ICT system for civil registration and vital statistics must include mechanisms to ensure the availability of data and the ability to restore data in the case of an adverse event, such as a natural disaster or the failure of hardware.

(b) Rationale

The digitization of civil registration records is an enhanced method of record preservation with critical advantages, including improved speed of storage and retrieval. Complex IT systems are vulnerable to risks to their stored data, however, such as data corruption, data loss, malicious damage and hardware failure.

(c) Implications

As part of a formal risk assessment, recovery time objectives[10] and recovery point objectives[11] should be captured. These will enable solution providers to determine the appropriate backup mechanisms required. Backup and restoration mechanisms and plans should be regularly tested to ensure that they remain effective. The records or databases created by a backup procedure should be located in a different geographical area to mitigate the risk of natural disasters. All backups should be given the same level of protection – in other words, the same security measures – as the original.

12. Functional requirement 12: Disaster mitigation

(a) Description

ICT systems for civil registration and vital statistics should include measures to manage the impacts of natural and human-caused disasters. Disaster mitigation measures should include the possibility to export data and metadata and take into consideration: electricity supply to servers and data centres; physical security for premises; support for business continuity; and minimization of recovery point objectives to prevent or minimize potential data loss. During implementation of the ICT systems, disaster recovery tools and routines, such as daily backup or a mirror site, should be put in place.

10 "Recovery time objective", or RTO, often refers to the amount of time that an application, system and process can be down without causing significant damage to the business and the time spent restoring the application and its data to resume normal business operations after a significant incident.

11 "Recovery point objective", or RPO, generally refers to the calculation of how much data loss a company can experience within a period most relevant to its business before significant harm occurs, from the point of a disruptive event to the last data backup.

(b) Rationale

Many countries are at risk of hazards, both natural and unnatural, which could affect civil registration infrastructure, including ICT systems for civil registration and vital statistics. Mitigating these risks is crucial to ensuring the sustainability and stability of the civil registration and vital statistics system.

(c) Implications

The implementation of ICT systems for civil registration and vital statistics should include disaster recovery measures grounded in effective ICT management practices, such as system backup and restoration capabilities. It is essential to store backups in another geographic location or in the cloud in order to mitigate the impact of a disaster.

13. Functional requirement 13: Security information and event management capability

(a) Description

The security system referred to as "security information and event management" helps organizations to recognize potential security threats and vulnerabilities before they are able to disrupt business operations. It identifies user behaviour anomalies and uses artificial intelligence to automate many of the manual processes associated with threat detection and incident response.[12] The ICT system for civil registration and vital statistics consistently conduct system audits to facilitate the constant monitoring of risks and should also pursue International Organization for Standardization (ISO) certification. All systems should have a robust mechanism of user authentication and authorization. Instead of adopting the typical identity code and password method, two-factor authentication, with a secondary verification method, via a separate communication channel, known as "out-of-the-box authentication", is recommended.

(b) Rationale

This requirement certifies that the ICT system for civil registration and vital statistics, business process, service and documentation procedures have all the requirements for standardization and security assurance. It also helps to avert and identify risks that could affect the system.

(c) Implications

Both internal and external audits should be envisaged to ensure adherence to international standards and avert possible system hacks and data manipulation. The system of choice should facilitate the implementation of security information and event management processes, with a view to identifying security incidents in near-real time, and to enable action in a timely manner to mitigate or minimize any incidences.

12 For more details, see https://www.ibm.com/topics/siem#:~:text=SIEM%20solutions%20enable%20centralized%20compliance,meeting%20strict%20compliance%20reporting%20standards.

14. Functional requirement 14: Analytics

(a) Description

Analytics is an advanced feature of data use, designed to produce knowledge for the decision-making process. The analytics platforms consist of specialized software, and the ICT system for civil registration and vital statistics should be able to connect to third-party analytics platforms to support the analysis of vital statistics and the monitoring and evaluation of public policy.

(b) Rationale

Analytics facilitate the analysis of vital statistics in order to identify patterns and trends in the data collected during the registration of vital events such as births, deaths and marriages. By analysing these data, Governments and other stakeholders can gain insights into the health public policies and well-being of their populations, identify areas where interventions are needed and track progress toward development goals.

In addition, analytics can help in the identification of errors or inconsistencies in the data and the adoption of corrective action to improve their accuracy and completeness.

(c) Implications

Countries need to incorporate analytics capabilities in their digital ICT systems for civil registration and vital statistics. A variety of platforms are available for this purpose, offering both open-source and commercial solutions. By leveraging these analytics functions, countries can gain valuable insights from the data collected through civil registration and vital statistics systems, which can inform evidence-based policies and interventions to improve the health and well-being of their populations.

B. Non-functional requirements of digital civil registration and vital statistics systems

Non-functional requirements relate to the operating level and performance characteristics of the system. Non-functional requirements are criteria relating to the operational characteristics of a system that should be considered when selecting a product. While functional requirements define the system's fundamental behaviour, non-functional requirements set out how the system will carry out this function. Unlike functional requirements, non-functional requirements do not form the backbone of the system but are critical for its efficiency. That means that the system will still work, even if the non-functional requirements are not met. At the same time, the role of non-functional requirements should not be underplayed.13 While functional requirements are primarily focused on the client's needs, non-functional requirements are more user-oriented. The key non-functional requirements for a digital approach to civil registration and vital statistics are outlined below.

1. Non-functional requirement 1: Usability

From a user perspective, the ease of use of the software or platform should be considered, namely, the extent to which it is configurable with a multitude of options, its ability to sup-

13 For more details on such requirements, see https://www.uptech.team/blog/functional-vs-non-functional-requirements.

port local languages, its capacity to support language packages that allow for easy translation into the language of choice and the intuitiveness or user-friendliness of the user interface.

2. Non-functional requirement 2: Reliability

Reliability is the ability of an application to run consistently without failure over time. To meet this requirement, the software or platform should allow for and implement regular system and data backups for use in case of failure. In addition, the system should be reviewed to assess how likely or unlikely it is that the technical components will hold up or fail over time, based on internal characteristics and external conditions.

3. Non-functional requirement 3: Scalability

The scaling of digital systems that are data-intensive requires the application to maintain consistent performance without crashing or stalling, as the number of users and data grows over time. For platforms hosted on local servers, the ability to scale also depends on the infrastructure in place. For systems hosted remotely, Internet connectivity will need to be considered.

4. Non-functional requirement 4: Auditability

It is recommended that the system should be auditable so as to ensure the transparency of the data processing and the consistency of the procedures performed by the users. In addition, the source code should be available for special audits.

5. Non-functional requirement 5: Documentation

Regardless of whether the software is developed in-house or outsourced, the software must be supported with detailed documentation of its operations for the users and technical characteristics for the ICT support staff.

6. Non-functional requirement 6: Security

The system should be protected from unauthorized access, use, disclosure, disruption, modification or destruction of the data of the civil registration and vital statistics system in order to ensure their confidentiality and integrity. This can be achieved through the implementation of cryptographic methods to protect the civil registration and vital statistics system from unauthorized access and prevent malicious adulteration of data, among other measures.

7. Non-functional requirement 7: Optimal performance

The system should have optimal performance for the most common procedures of the civil registration and vital statistics system, such as capturing, searching and retrieving data from the database; printing certificates; and listing reports, among others. This performance should be assured by the basic characteristics of the ICT hardware and networking equipment of the civil registration and vital statistics services.

8. Non-functional requirement 8: Relevance to the local telecommunications context

The country's telecommunications infrastructure needs to be taken into consideration when implementing and developing an ICT system for civil registration and vital statistics. Network

capabilities, whether for wide area network or local area network, are a key requirement for data interoperability, data-sharing and data integration.

9. Non-functional requirement 9: Online and offline access options

In countries where Internet connectivity is a challenge, it is essential that the ICT system for civil registration and vital statistics should be able to function in both online and offline modes.

10. Non-functional requirement 10: Mobile device capabilities

Systems can be designed to work on mobile phones and tablets. A mobile application that works offline and seamlessly connects to remote servers is preferred.

11. Non-functional requirement 11: User alerts

User alerts sent to clients by text message, the Unstructured Supplementary Service Data (USSD) communications protocol, email or other channels such as social media, for example, to notify clients that requested certificates are available for pick-up or to update them about the status of their applications, can improve service delivery in a civil registration organization.

III. Licensing models for digital civil registration and vital statistics systems

Once the digitalized civil registration process has been designed, the technical application requirements have been specified on the basis of the fundamental principles, and once an agreement has been reached on the main functional and non-functional technical requirements, it is time to choose the appropriate source code licensing model. This decision is crucial for the implementation strategy of the civil registration and vital statistics application.

When choosing a suitable licence model, it is crucial to weigh the benefits and risks of each option and consider the findings of a comprehensive assessment; this will help in determining suitable choices for the country's specific needs.

There are two main types of source code licensing models for digital civil registration and vital statistics systems, namely, a proprietary commercial software licence and open-source software licence. The present chapter outlines the key benefits and risks or disadvantages that a country would encounter in adopting one or the other licensing option.

A. Proprietary commercial software licence

A proprietary commercial software licence is a legal agreement between the software vendor (a company or individual) and the client (an organization, such as the civil registration agency) that grants the client the right to use the software under certain conditions. This type of software is typically sold for a fee and is protected by copyright law.

1. Benefits

Proprietary commercial software licences are perceived as having the following benefits:

a. The time used to purchase the software is much less than the time spent developing the same software;

b. Often, fewer resources in terms of human capital are required;

c. In addition to the actual software, the country will also benefit from the company's experience in developing and installing the ICT system for civil registration and vital statistics, leading to less-risk and a more robust implementation;

d. The system is more reliable, as commercial software is generally tested for more varied uses and to meet different security requirements;

e. System customization may be considerably limited in the case of off-the-shelf systems;

f. The system can be evaluated before purchase;

g. The system is maintained by the vendor and often upgraded, albeit usually at a cost;

h. Access to a source code may be included in the contract; clients are not allowed to change it, however.

2. Disadvantages and risks

At the same time, proprietary commercial software licences present the following disadvantages and risks:

a. Purchasing a commercial system often also entails reliance on the implementing vendor for ongoing support. There is a risk of the client becoming dependent on the vendor and of the vendor being unable to provide the required support, if, for example, the company goes bankrupt or decides to discontinue the software;

b. Commercial software suppliers will want to protect their intellectual property, such as the source code, database schemata and instruction manuals. It is important to discuss and understand the intent and scope of this protection to ensure that it is clearly understood by all parties and any risks are mitigated. Regardless of the intellectual property of the software, the contract must establish that the country is the owner of the data;

c. It may prove necessary to customize the software to fit individual business functionalities fully, and this may be expensive and time-consuming, if not initially discussed or understood at the beginning of the project. Introduction of the business process should be performed before it is customized to reduce costs and ensure that the ICT system for civil registration and vital statistics fully conforms with the country's legislation and technical requirements – in other words, the country's civil registration process should not be determined by the commercial ICT system;

d. Where the software is licensed periodically or for a set number of users, the vendor may charge fees for additional users or usage of the system. It is important that this is discussed and understood at the beginning of the project;

e. The system is often expensive and sold with unclear, complex fees, such as a per-user fee which may be combined with other criteria;

f. There are always new requirements to improve the system. Any modification of new applications would incur additional costs and the need for technical support. Priorities in the product's evolution may not be aligned with the needs of the Government, resulting in expensive customization and maintenance;

g. At the end of the contract, there is a high risk of discontinuity of the civil registration and vital statistics services or strong limitations on migration to another system. The licence must ensure full access to data and to the tools needed to migrate those data to another database;

h. The system often requires integration with, or is dependent on, components that are developed and supported by other organizations, adding a further level of complexity to the approach.

B. Open-source software licence

Open-source licences allow software to be freely used, modified, and shared.14 The source code and the software product are freely available. The professional services required to customize or implement the software may be paid or free, however, depending on the devel-

14 An extensive list of licences that comply with the definition of an open-source initiative licence is available at https://opensource.org/licenses/.

oper's business model. The software is usually supported by a community of developers and users.15

1. Benefits

The following benefits are generally associated with open-source software:

a. There are no upfront costs, but implementation, maintenance or customization of the software is likely to require investment;

b. Clients have the right to make changes to the software;

c. Clients may engage the local ICT industry in customizing, maintaining and implementing the software;

d. Open systems are typically designed to adapt to a range of different infrastructures and environments and are likely to be already equipped with data exchange and data-sharing facilities;

e. The software benefits from its community of practice and from updates and enhancements of functionalities included in other jurisdictions in which it is being implemented;

f. The system may be evaluated before it is acquired;

g. Development costs can be shared with other organizations or countries.

2. Disadvantages and risks

Possible disadvantages and risks of open-source software include the following:

a. A loosely-knit community of users and developers might not be able to provide the business relationship needed or the necessary liability and accountability considerations and, if the community is not sufficiently strong, it may not be able to maintain the software;

b. While open-source software eliminates the need for licensing fees, resources and a budget will still be allocated for the configuration, implementation and system operations;

c. The lack of local technical support and requisite human resources in the country could jeopardize implementation; for example, local developers may not be familiar with the programming languages or underlying technologies involved;

d. Free and open-source software often requires integration or dependencies with components that are developed and supported by other organizations, adding further complexity to the system.

C. In-house software development

The choice between in-house or outsourced software development is a critical decision that the civil registration and vital statistics institution needs to take when digitalizing its civil registration and vital statistics system.

15 The Pacific Community has recently supported Niue in implementing open-source software for civil registration and vital statistics which has been licensed at a national level.

Outsourcing the development of civil registration and vital statistics software involves contracting external software development firms or freelance agents to provide the desired software, offering distinct benefits. Outsourcing can enhance cost-efficiency, in particular for short-term projects, by eliminating the need for in-house technical staff. Speed is another advantage, as experienced outsourcing partners can expedite project timelines through resource leverage. Furthermore, outsourcing permits organizations to scale resources up or down to meet project demands, providing valuable flexibility.

The principal disadvantage of outsourcing development of the system derives from the development firm's lack of knowledge, potentially requiring the allocation of additional internal resources and investment of more time than expected to provide support. The technical know-how can be retained by the outsourcing company or resources, creating potential dependency and vendor lock-in.

The decision of whether to develop software in house or to outsource its provision depends on various considerations, such as budget, staff expertise and timeline. Ultimately, the decision should be based on the organization's goals and available resources. It is essential to choose an approach that best supports compliance with the fundamental best practices in the digitalization of civil registration and vital statistics presented in previous sections of the present guide.

Many civil registration and vital statistics offices create their own software with the help of public servants or consultants. A recent study by the African Development Bank revealed that 72 per cent of African countries use custom-built software for their civil registration and vital statistics data systems.[16] To protect their ownership of the software and source code, it is vital for all professionals involved in the development process to sign a commitment agreement.

Indeed, in-house software can be tailored specifically to meet the organization's unique requirements. This means that the system's technology, functionality and design can be fully controlled and customized according to the organization's preferences. By following an in-house approach, the organization can optimize its operations and ensure that the system works exactly as it needs.

Another advantage of in-house software is its potential for seamless integration with other governmental systems, such as the national identity management and population registry, allowing the creation of a fully integrated ICT infrastructure across the country.

When the system is developed by internal staff members who understand the organization's requirements and business processes, they can add significant value by suggesting alternatives and improvements. They can provide valuable ICT advice and information based on their knowledge of the organization's operations and objectives. This development experience fosters a sense of ownership and accountability within the organization, leading to better sustainability and long-term support for the system.

In addition, engaging the local ICT industry in harnessing development opportunities promotes local capacity.

By contrast, the development of in-house software has certain disadvantages. For example, it may not take advantage of the valuable experience and lessons learned from other juris-

16 African Development Bank, "Assessment of the status of digitalization/digitization of CRVS systems in Africa", Statistics Department, n.d. Available at https://apai-crvs.uneca.org/sites/default/files/resourcefiles/ digitalization_of_crvs_system_in_africa_afdb-january_2023.pdf.

dictions that have implemented similar systems. The lack of knowledge transfer can lead to unnecessary challenges and delays in development and implementation and may result in the development of software components that have already been developed in other jurisdictions and can possibly even be available as open-source software.

The developing and testing of an entire software system entails a higher level of risk than the use of pre-existing commercial or community-supported open-source software. For software developed in house, the civil registration and vital statistics organization must invest significant effort, resources and time in thorough testing and quality assurance to minimize the risks associated with potential bugs, vulnerabilities or compatibility issues that may arise during the implementation and operational phases.

The financial investment required to develop software from scratch is typically higher than that for the adoption of commercial or community-supported open-source software. It needs dedicated resources, including skilled developers and project management expertise, which may increase the overall costs. In addition, ongoing maintenance, support and updates may require continued investment, in particular if the organization relies heavily on the developers for support services. The higher costs associated with in-house software development should be carefully considered, in the light of possible budget constraints and their effects on long-term sustainability.

If the civil registration and vital statistics organization opts to hire consultants to develop the software, challenges may arise, primarily if there is a lack of the internal expertise needed to maintain and troubleshoot the system. This may create a dependence on the consultants.

The process of developing and supporting an in-house civil registration and a vital statistics system heavily relies on local technical skills. In regions with a shortage of skilled professionals or limited access to specialized expertise, developing and maintaining an in-house solution may face challenges.

Another disadvantage or risk of an in-house solution is the difficulty of migrating the technology in the future. If knowledge and technical documentation are primarily held by the developers or not adequately documented, it may prove very difficult to transition to a different technology or vendor. The organization may depend on the original developers for ongoing support and maintenance, limiting future flexibility and adaptability.

D. Software modification and migration of data

It is important to note that the ability to make modifications to the ICT system for civil registration and vital statistics and to migrate data to another system are key requirements regardless of which type of software is chosen. Countries should endeavour to ascertain from the vendor the cost and licensing implications of any required changes to the standard commercial system to enable it to meet the specific requirements of the country and the process for the migration of data. When analysing the potential changes needed and the need eventually to migrate to a new system, the following components should be clearly understood:

a. Cost of change: the fee to be charged by the implementing vendor to make the changes (including any upfront costs and also any effects on subsequent maintenance or support fees);

b. Time to make change: the time needed to make the changes and the need for this to be integrated into the overarching project plan;

c. Risks of testing a new system: the number and extent to which various components of the software, such as the database, business rules, user interface, security measures, outputs and others, need to change and the risks associated with testing the new system, including the risk of making other components of the system unstable. This is the greatest challenge to completion of the project and it needs to be given careful consideration;

d. Intellectual property: ownership of the intellectual property derived from any changes made, including whether the vendor wants or expects the changes to form part of the vendor's standard product made available to other civil registration offices;

e. Business continuity during migration to a new system: the expectation of and planning for migration to another system, given that every system has a limited lifetime. The licence and the contract should facilitate the migration to a new system and ensure continuity of the civil registration and vital statistics services during this process.

IV. Hosting options

When implementing a digital civil registration and vital statistics system, the infrastructure that supports its operation – namely, the central hardware that will be running the system and storing the data being collected – is crucial. The choice of hosting services which will provide that infrastructure significantly affects adherence to principles like sustainability, data accessibility, security, and privacy. Moreover, deciding where to host and maintain the ICT system and the data requires the consideration of technical and human resource aspects, such as server space, power supply, security and privacy protocols, anti-virus software, back-up servers and the need for skilled personnel to manage these systems. As such, it is essential to conduct a thorough analysis to select the most appropriate hosting option.

There are numerous options for hosting, which primarily fall into two main categories: self-hosting models, in which the civil registration organization retains complete control over the infrastructure, and cloud hosting, where hosting services are outsourced to an external service provider. A recent assessment by the Africa Programme on Accelerated Improvement of Civil Registration and Vital Statistics Systems and the African Development Bank shows that 72 per cent of African countries use a self-hosting model for their civil registration organization.[17] An outsourced hosting model should still be considered, however, when deciding on this important issue. While many countries may have concerns about the reliability of hosting with a cloud computing service, there is a growing global trend towards the use of this model18 and it may be wise to consider this alternative.

The benefits and disadvantages of these two models are further explored below.

A. Self-hosted model

The software and data are hosted internally by the civil registration organization or by another governmental agency responsible for the national ICT data centre. The model can also be defined as "on-premises hosting" because the ICT infrastructure, applications and data are physically located within the premises of the civil registration organization. This means that

17 African Development Bank, "Assessment of the status of digitalization/digitization of CRVS systems in Africa", Statistics Department, n.d.

18 Australia and New Zealand have recently adopted cloud storage for their civil registration and vital statistics data.

the agency authority owns and cares for the hardware, software and infrastructure needed to host its ICT systems and data. The adoption of so-called "virtualization"[19] technologies is highly recommended even for self-hosted approaches. Moreover, self-hosting can make use of cloud technologies, such as load balancing and containerization,[20] in an approach known as "private cloud hosting". In this approach, the hosting platform will be used exclusively by that organization and is not shared with other external users or organizations.

1. Benefits

Self-hosting is perceived as having the following benefits:

a. The servers and data remain completely under the control of the civil registration agency;

b. The civil registration agency can maintain complete control of software, functions and features;

c. Software decisions remain entirely at the discretion of the civil registration agency;

d. The civil registration agency can use self-hosting as an opportunity to build and strengthen the agency's internal ICT capacity and close its skills gap.

2. Disadvantages and risks

At the same time, self-hosting entails a number of potential drawbacks:

a. Servers are subject to the vagaries of the local environment, such as power outages, other accidents, flooding, fires, earthquakes and others;

b. A disciplined approach will be required to maintain backups and procedures for disaster recovery;

c. There may be limits on performance and capacity to quickly integrate cutting-edge applications and innovative initiatives;

d. The civil registration agency will be responsible for maintaining the operating system, applying software patches and upgrades and adding devices, as required;

e. More demands will be placed on the local ICT staff;

f. Ownership will entail potentially higher total costs;

g. Investment will be needed in physical security, incident management practices and backup management, which may be difficult to support;

h. Generally, ICT costs will be high, representing significant investment for a government department which has limited or no ICT capabilities, such as the civil registration authority.

19 Virtualization is a technology that allows multiple virtual instances or virtual machines to run on a single physical server or host machine. Each virtual instance operates like a separate physical server with its own operating system, applications and resources.

20 The "containers" in this approach are software systems such as Docker and Kubernetes that facilitate the packaging and deployment of applications and their dependencies in isolated, portable containers.

B. External hosting, including cloud computing

This may be provided by a governmental or private service provider. In this case, the civil registration authority will not have full control of the infrastructure used by its ICT system and it will therefore be important to implement legal and technical measures to ensure that data ownership remains with the civil registration authority and that changes to the ICT system are possible. Specifically, the retention of complete control over the software and all its functions and features is necessary and should be included as a clause of the contract.

If a civil registration authority switches from a self-hosted to an outsourced model, it is vital that it develop a transition plan and prepare its ICT staff for this change.

The current trend is to switch to cloud computing. In this model, the applications are fully hosted on remote servers, the software is sold (or offered freely) as a service that can be contracted to each user on a per-month or per-year and per-record basis, or by volume of records, and the software vendor usually offers it as a package available on the Internet.

Hiring a cloud computing service of this kind is the most common form of outsourced hosting. Outsourced cloud services are also referred to as "off-premise" or "public cloud" services and may include well-known providers already used by countries, such as Amazon Web Services, Oracle, Microsoft or Google.

The major concern associated with external hosting is the need to give up so much control. Even though employees at reputable cloud hosting vendors undergo background checks, some organizations are uncomfortable with the idea that another entity will be handling and possibly have access to their data. Some countries have laws which address these concerns, in which case the choice of vendor and the geographical location of their data centres are important considerations in terms of the applicable law.

It is possible to adopt a hybrid cloud model that includes both public and private cloud services, respecting legal and technical requirements. In this case, sensitive data are hosted in a private cloud. Such hybrid approaches can balance the benefits and risks of cloud computing.

1. Benefits

Generally, external hosting approaches are seen as presenting the following benefits:

a. Outsourcing hosting services may be more cost-effective than in-house hosting of the system. They can eliminate the need to procure hardware, software and the core data centre infrastructure. Moreover, larger data centres benefit from economies of scale, enabling them to reduce operational costs;

b. Specialized data centres are often more flexible and can adapt quickly to unexpected demands and new needs without embarking on a lengthy procurement process or compromising quality or speed;

c. Providers in hosting services have teams of highly specialized experts dedicated to managing and maintaining their services;

d. Civil registration and vital statistics organizations can focus on essential activities, including improving the functionalities of their ICT system, which is then hosted by a dedicated organization;

e. Outsourcing providers typically have redundant systems and backup procedures to ensure that the system remains available during a disaster or outage;

f. Most cloud providers offer some degree of protection at least at the infrastructure level, such as intrusion detection and protection against denial-of-service attacks;

g. Cloud computing employs high levels of automation of routine tasks, which can help to streamline operations and optimize the available resources.

2. Disadvantages and risks

The following main drawbacks are associated with external hosting:

a. Maintaining a consistent connection between the practitioner and the data centre can be difficult, owing to challenges in the telecommunications infrastructure. If the Internet goes down, access to remote data stores will be lost, although this can be mitigated by maintaining on-premise mirror stores;

b. By using an external data centre, the civil registration and vital statistics agency risks losing total control of its ICT system. Measures must be put into place to ensure that data ownership remains with the civil registration and vital statistics authority and that changes to the ICT system for civil registration and vital statistics are possible. Addition considerations should include the physical security of the data centre, such as access controls, employee screening and others. Specifically, the retention of complete control over the software and all its functions and features is necessary and should be included as a clause of the contract;

c. A private provider may offer low initial prices but charge additional fees for services that were assumed to be included. The hidden costs may result in unexpected expenses and administrative problems. Where necessary, the civil registration and vital statistics authority may wish to seek support during contracting to ensure that such eventualities are considered. Civil registration and vital statistics organizations are often not well positioned to pay a regular service fee.

C. Combined models

As indicated above, adopting a hybrid model that combines self-hosting and cloud hosting is also possible. In a hybrid cloud set-up, data and workloads can move seamlessly between the two infrastructures, allowing organizations to leverage the benefits of both models.

Although running a data centre often ends up costing more, except in specific cases of organizations with high technical capabilities and intense resource needs, the advantage of a data centre is that money is spent upfront as a capital expenditure, an approach which, in many organizations, is easier to sell to upper management or donors. In most cases, however, a financial analysis which factors in amortization, replacement costs and the cost of the required human resources would clearly shift the picture in favour of cloud hosting.

Most developing countries face difficulties in establishing an advanced connectivity infrastructure and have concerns about data sovereignty. These two factors are barriers to the widespread adoption of the cloud hosting model. If the civil registration and vital statistics agency decides to migrate to cloud hosting, it is highly recommended that it adopt a gradual and pragmatic strategy for such migration.

V. Procurement considerations

A. Procurement approach

The procurement process entails determining the requirements for the ICT system for civil registration and vital statistics, communicating with suppliers, administering contracts and assuring the quality of the products and services procured.

The procurement of ICT systems for civil registration and vital statistics is at the core of the civil registration organization's business, as any changes effected may have a significant impact (whether positive or negative) on the performance of the organization, including its relationship with other stakeholders with whom civil registration services and products could be linked, such as the health system, the identity management system, the statistics system and others. Procurement processes should therefore be managed carefully and led by appropriate professionals knowledgeable about the requirements of the system and the acquisition procedures.

Within the civil registration organization or as a part of the broader government ministry, there should be an established model or protocol for ICT procurement which provides guidance about managing procurement procedures and tasks and enables collaboration between the individuals involved in the ICT system procurement process. Such a model is important as it serves as a framework for management teams to make the process of acquiring ICT systems easier, transparent and comprehensive.

A generic procurement process begins by setting up the context and status of the civil registration and vital statistics system, based on an earlier assessment. This includes answering critical questions such as:

a. What performance issue or challenge is the civil registration agency seeking to address through a new ICT system?[21], [22]

b. What is the extent of the challenge?

c. What alternative solutions are there to the challenge?

d. What are the benefits, costs and risks of engaging in the procurement of a new system?

Then, requirements are gathered to establish a business case for the ICT procurement process in alignment with the vision and goals of the civil registration and vital statistics system and organization (see chapter I above) and the technical requirements (see chapter II above) of the system and organization.

21 A comprehensive analysis of the existing civil registration and vital statistics business processes should be undertaken to identify possible weaknesses and redundancies. Guidance on how to undertake a business process analysis is provided in Vital Strategies, *CRVS Systems Improvement Framework* (n.p., 2021), available at https://www.vitalstrategies.org/resources/crvs-systems-improvement-framework/. This should be followed by a redesign of processes, on which the ICT system would be built. It should be noted that the digitalization of ineffective civil registration and vital statistics processes would result in similarly flawed and ineffective processes. As such, it is imperative that any digitalization process be preceded by informed analysis.

22 Comprehensive guidance on how to approach the digitalization project, including the analysis of business processes leading up to implementation of the ICT system, may also be found in the online resource, CRVS Digitisation Guidebook, developed by ECA for the Africa Programme on Accelerated Improvement of Civil Registration and Vital Statistics and available at http://www.crvs-dgb.org/en/methodology/.

B. Total cost of ownership

Another important consideration of the procurement team should be the implementation and running costs of the ICT system. The cost of implementing and operating an ICT system for civil registration and vital statistics varies, depending on the technologies and systems chosen, and also the scope and scale of implementation.

When selecting which ICT system to procure, it is important to consider the total cost of ownership, which is composed of, first, the initial costs of implementation and, second, the operational costs, as detailed below.

1. Initial costs of implementation

ICT vendor services	Software licensing ICT system deployment and configuration Data migration Training Documentation Implementation support Warranty
ICT infrastructure	Servers Data storage devices Computer networking equipment Computers Mobile devices Printers and scanners Third-party software licensing

2. Operational costs

ICT vendor services	Software licensing Post-warranty support and maintenance
Hosting	Hosting of an ICT production system Hosting of ICT development, test and training systems Hosting of an ICT recovery system Storage of data backups
IT infrastructure replacement and renewal	Servers Data storage devices Computer networking equipment Computers Mobile devices Printers and scanners Third-party software licensing

Acquisition is followed by the contract execution stage, which entails managing and coordinating all the activities associated with the fulfilment of the ICT procurement contract requirements. This stage includes acceptance of the products and services provided, installation of systems and management of warranty and maintenance services.

During this stage, irrespective of the digital system that is chosen for implementation, it is essential to ensure that sufficient knowledge, information and training is provided by the ICT software supplier to the national ICT and civil registration and vital statistics staff to ensure

that adequate capacity is built locally for the daily maintenance or operation of the system. Written protocols of essential features of the software and how it is to be managed should be provided to the country and simplified to the maximum extent possible. The national team should also make every effort to ensure that the terms of contract are met by the supplier and that any matters are addressed in a timely manner. In addition, it is important that any changes arising from the procurement process be made in a timely manner and without impeding business continuity.

C. Stages of procurement

Following an established six-stage model will help to ensure that the procurement process adheres to best practices and mitigates any possible risks.

1. Planning the procurement

- Securing financial resources, whether from the national budget or donor funding;
- Defining the technical team responsible for meeting the requirements;
- Preparing the terms of reference: current system description; vision; functional and non-functional requirements;
- Receiving authorization to initiate the procurement process.

2. Launching a request for expressions of interest

- Calling initially for expressions of interest enables the purchaser to find out what vendors are offering;
- After calling for expressions of interest, the purchaser can make decisions about which contractual aspects are not negotiable (hosting, source code rights and others);
- Based on the expressions of interest, a shortlist can be drawn up of providers to which the request for proposals will be sent.

3. Defining tender selection criteria and drafting the request for proposals

- The request for proposals for an ICT system for civil registration and vital statistics should be drafted on the basis of a consultative process involving relevant stakeholders;
- The request for proposals should be specific. Tightening the criteria will ensure that responses are carefully targeted and more easily compared;
- The profile of the type of vendor required should be specified, with a view to favouring vendors that can offer local support in the country;
- Vendor warranty, maintenance and support services after implementation should be included in the procurement package;
- Rather than specify restrictive hardware requirements in the request for proposals, the vendor should propose the appropriate hardware for the ICT system being offered, indicating whether it is compatible with the government ICT infrastructure (for example, the existing data centre where the ICT system will be hosted).

A checklist with recommended content for the request for proposals is provided in annex I to the present document.

4. Releasing the request for proposals and responding to bidders' questions

- The request for proposals should be released with enough lead time for proposal submission;
- Questions raised by bidders should be discussed and answered in writing.

5. Evaluating proposals

- The evaluation should consider the total cost of ownership, comprising both the initial implementation and operational costs of the ICT system;
- Consideration should be given to sending a list of questions and areas to be clarified to the bidder, along with a time frame for the provision of responses;
- It is important to ensure that the hardware proposed by the vendor is of good quality and fits the target ICT environment;
- Valuable insights can be gained from reaching out to other countries implementing the ICT systems offered by the bidders, to collect feedback on the performance of the specific vendors' ICT systems.

6. Awarding, negotiating and signing the purchase contract

- The drafting of a purchase contract for an ICT system is of utmost importance, as it will legally define the relationship with the vendor and determine what is expected from the vendor;
- Vendor warranty, maintenance and support services should be well outlined within the contract, along with the delivery of a functional ICT system;
- The cost of developing new features for the ICT system during its lifetime should be included in the contract;
- Documentation (e.g. manuals, passwords) to be handed over during implementation of the ICT system should be indicated in the contract;
- In cases in which the software is licensed for a given time frame, number of sites or number of users, the vendor may charge fees for additional users or usage of the system. It is important that the contract clarify the terms for application of such provisions;
- It should be made clear in the contract that all data are owned by the Government (or its citizens, depending on the legal framework), and the vendor can neither claim ownership over data nor withhold access to them;
- The contract should clearly define the legal framework under which the contract is managed, as well as the legal jurisdiction where the data will be stored (preferably the country where the ICT system is being implemented);
- A software escrow arrangement should be set in place to ensure that the ICT system source code is held by a third party and is accessible to the Government (and can be further maintained and developed by the Government or another vendor) in the event that the vendor ceases to exist as a consequence of bankruptcy;
- Periodic reviews of vendor performance should be included in the contract, as well as provisions on how to handle the transition if the contract is terminated.

A checklist with recommended content for a purchase contract may be seen in annex II to the present document.

Following implementation, a new phase of procurement management entailing the overall governance of ICT procurements is initiated. This phase includes the management of the vendor-supplier relationship and the management of the assets acquired, including the development of asset management strategies and quality management, which entails the need for continuous improvement in the procurement management process and in all the products and services provided for ICT purposes within the organization.

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Annexes

I. Procurement checklists: content of a request for proposals

No.	Actions	Descriptions	Assigned person	Due date	Status
1	General actions	Scope of request for proposal			
		Request for proposal process			
		Eligible bidders			
		Required qualifications of the bidder			
		Agency and person in charge of the procurement			
2	Technical requirements	Functional requirements			
		Non-functional requirements			
		Hardware compatibility requirements			
		Testing requirements			
		Implementation schedule			
		Warranty, maintenance and support services required			
3	Preparation of proposals	Language of the proposal			
		Documenting process of the proposal			
		Proposal price and currency			
		Period of validity of the proposal			
4	Submission of proposals	Deadline for submission			
		Late proposals			
		Withdrawal, substitution and modification of proposals			
5	Evaluation of proposals	Opening of proposal by purchaser			
		Clarification of proposals			
		Criteria for verification of requirements (mandatory and optional)			
		Evaluation and comparison of proposals			
		How to contact the purchaser			
6	Contract award	Award criteria			
		Notification of award			
		Preparing justification for elimination of bidders			
		Contract negotiation			
		Signing of contract			

II. Procurement checklists: content of a purchase contract

1. General

- Definitions
- Notices
- Governing law
- Settlement of disputes

2. Subject matter of contract

- Scope of the system
- Implementation schedule
- Supplier's responsibilities
- Purchaser's responsibilities

3. Payment

- Contract price
- Deliverables and percentage of payments
- Terms of payment
- Taxes and duties

4. Intellectual property

- Copyright
- Software licence agreements
- Confidential information

5. Supply, installation, testing, commissioning and acceptance of the system

- Representatives of contractual parties
- Project plan
- Design and engineering
- Inspections and tests
- Installation and configuration
- Acceptance
- Training of government staff
- Handover

6. Services

- Training
- Warranty
- Corrective maintenance
- Evolutive maintenance
- Support
- Development of new functionality

7. Data

- Data privacy
- Information security
- Legal jurisdiction
- Data ownership

8. Guarantees and liabilities

- Warranty and defect liability
- Loss of, or damage to, property
- Accident or injury to workers
- Indemnification
- Insurances
- Force majeure
- Software escrow

9. Change in contract elements

- Changes to the contract
- Changes to the system
- Termination