4. Barriers to and drivers of digital transformation

This chapter explores digital transformation across four dimensions individual, technological, organisation and process, and system and environment. Through interviews and surveys with NSOs, as well as literature reviews, this chapter outlines specific examples of drivers and barriers to digital transformation.

Although the situation in each country or territory is different, it is possible to identify a few typical barriers (that block, impede or slow down the digital transformation) and drivers (that enable, facilitate or accelerate the digital transformation). This chapter discusses some of these across different aspects within each of the four dimensions of digital transformation (individuals, technologies, organisation and processes, and system and/or environment) of national statistical offices (NSOs). As each context is different, the discussion of these drivers and barriers should not be understood as prescriptive for all.

4.1. Individuals

Recruitment and retention

Barriers

- Public sector salaries are often not competitive with private sector salaries, making it hard for NSOs to acquire talent and retain skilled staff over the long term.
- Rapid staff turnover causes knowledge gaps and discontinuity.

Drivers

- A modern information technology (IT) infrastructure creates a virtuous circle, enabling innovative approaches that make the NSO a more attractive workplace for recruiting and retaining skilled employees.
- The efficient storage, retrieval and exchange of knowledge are essential to any innovation within an organisation (Colombo, 2020[37]). This allows sectoral units to work together and understand each other better; helps them avoid repeating the same mistakes or re-inventing the wheel; and facilitates knowledge retention, especially in contexts with high staff turnover. A comprehensive knowledge management approach, one that goes beyond a simple document management system and actively supports knowledge flows and knowledge uptake, can significantly speed up a digital transformation. At the same time, the digital transformation itself can also generate a virtuous circle of improving and facilitating knowledge sharing within the NSO and within a broader community of practice such as the national statistical system (Capgemini Consulting, 2011[4]).

Capacity development planning

Barriers

- Capacity development measures in low and middle-income countries, more often than not, are donor-triggered - that is, supply-driven rather than driven by demand and need. Workshops, training and study tours are often designed to fit the needs of a specific project and may not fully fit the NSO's actual long-term needs and goals. A typical example is training on specific statistical software that has been implemented within a project but otherwise is not used more broadly by the NSO (e.g. because license costs are prohibitively high or another tool is well established in the NSO). In such a case, the capacity development measure could contribute to a worsening of unstandardised digital management rather than to a coherent and strategic usage of software and technologies.
- Capacity development measures can only deliver their full potential if the participants have an opportunity to apply the newly acquired skills in their everyday work. Supply-driven capacity development measures are often disconnected from the actual needs of NSO staff and/or cannot be applied directly (e.g. because the software on which staff were trained is not available or because the taught techniques and methods cannot be incorporated into the standard statistical

production chain). This hinders the actual adoption of the new skills and their integration into the NSO's work processes.

- Setting up a comprehensive recruitment plan is complicated by the speed at which technology is evolving, which makes it difficult to anticipate the skills and competencies that may be required the most in two, five or ten years.

Drivers

- A comprehensive learning and development strategy can boost the digital transformation by ensuring that the actual business needs (in terms of skills and competencies) drive the recruitment and implementation of capacity development activities. The Palestinian Central Bureau of Statistics has adopted this approach and takes it one step further by partnering with universities to actively shape and build the capacities of the next generation(s) of official statisticians. Its philosophy is that in the future, data scientists will be needed.

4.2. Technologies

Acquisition and maintenance of technologies

Barriers

- Substantial financial and human resources are needed to acquire and maintain the digital technologies and infrastructure needed for a coherent digital transformation, such as an internal network, internet connectivity, servers and personal computers, and software licenses. Such resources often are not readily available, especially for NSOs in low and middle-income countries.
- Dealing with digital (big) data requires specifically very substantial storage and processing capacities, which are not always to be found on NSO premises. While relocating the storage and processing on cloud infrastructure might appear initially to be an obvious, efficient and comparatively cheap alternative, this frequently conflicts with national data governance policies, for example, those stating that the national/territorial data must physically reside within the country/territory.
- Ad hoc technological development, which is often a consequence of externally driven projects, tends to result in a very disparate technological stack such as overlapping technologies running in parallel, low re-usability and maintainability, etc. This often occurs when technological approaches are designed specifically to meet a short-term need of a particular project, statistics, census or survey and not framed within a long-term, overarching digital strategy. The Kenya National Bureau of Statistics offers an example of this: Several (partly overlapping) dissemination platforms were deployed to accommodate the needs of specific projects, but the corresponding maintenance of all those platforms, as well as data integration and data quality assurance, are proving challenging.

Drivers

- A clear, specific and defined IT strategy, including a description of the NSO's digital landscape (status quo) and roadmap, can steer the choice and procurement of relevant technologies, therefore directly addressing some of the aforementioned barriers.
- Very high internal IT competencies and empowered IT departments can improve and speed up the identification, testing, deployment and long-term maintenance of demanding technologies.

The specific barriers to and drivers of implementing technologies depend strongly on the kind of technology in question.[1] Two specific technologies of particular relevance for NSOs - geospatial data and analysis and mobile phone data - are discussed in Box 4.1 and Box 4.2.

Box 4.1. The special case of geospatial data and analysis

Geospatial data are data that have a geographic component. Leveraging such data is a very powerful way to discover (spatial) relationships between (social, environmental and economic) phenomena. Satellite and aerial imagery, combined with positioning systems (e.g. the Global Positioning System, Glonass, Galileo), provides alternative sources of data for computing statistics.

Barriers

- Access to high-resolution satellite or aerial imagery can be very expensive, especially when full national coverage is required. Freely available lower-resolution satellite images can often offer a relevant and efficient alternative, but additional information provided by high or very high spatial resolution may be needed to conduct some specific activities and analyses.
- The lack of an open and comprehensive data-sharing policy or legislation can be a barrier to sharing with the NSO official spatial datasets (administrative boundaries, land use and/or land cover, etc.) owned and maintained by other government organisations. Even when available to the NSO, those datasets may not always offer sufficient quality or be up to date, which hinders their smooth integration into the statistical production chain.
- Advanced geospatial practices require very specific (and expensive) tools and very specific competencies (e.g. devices supporting stereoscopic vision) and involve very high entry costs at all levels (hardware, software, staff capacity development, design and implementation of new statistical methods, etc.).

Drivers

- The United Nations (UN) Economic and Social Council has established the Committee of Experts on Global Geospatial Information Management (UN-GGIM) for the purposes of making joint decisions and setting direction in terms of the production, availability and use of geospatial information within national, regional and global policy frameworks. Led by UN member states, the UN-GGIM aims to address global challenges regarding the use of geospatial information, including in the development agendas, and to serve as a body for global policy making in the field of geospatial information management.
- The wide availability of open source technologies — QGIS for desktop applications; PostGIS and GeoPackage for data storage, and Geoserver, GeoNode, Geonetwork and many others for data and metadata dissemination and sharing — drastically lowers the entry costs for NSOs that are starting to harness geospatial analyses in their statistical production. Open source does not necessarily mean free: Even open source technology can require investments in terms of capacity development, maintenance, etc. Yet, these technologies provide NSOs with a straightforward way to test, evaluate and start the integration of remote sensing and geographic information system, or GIS, technologies.
- Open geospatial data also are widely available to replace or complement the more traditional commercial and official datasets (e.g. OpenStreetMap, Natural Earth, Sentinel).

Box 4.2. The special case of mobile phone data

Mobile phone data have emerged in recent years as one of the most promising sources of (big) data for official statistics. Within the official statistics community, it is widely expected that mobile phone data can be harnessed to fill data gaps (mostly in developing countries) and produce very granular and timely statistics in a range of sectors, including, among others, population, tourism and migration. However, the technology used must be chosen wisely to avoid strong biases. A recent study found that in Uganda, smartphone mobility estimates may differ by as much as 40% from estimates related to more commonly used, basic mobile phones; the research further found that even relying on basic mobile phone data would leave a significant share of the population (mostly the poorer and more marginal groups) under-represented in the statistics (Milusheva, Björkegren and Viotti, 2021[38]).

Barriers

- The lack of specific legal frameworks, especially regarding data protection (access to and anonymisation of very granular personal data), is a significant barrier for NSOs seeking to harness mobile phone data in connection with a digital transformation.
- Ideally, 100% of the population and the national territory should have mobile phone coverage in terms of network and access to devices and mobile phone plans. As this is usually not the case, the dynamics at stake must be extremely well understood to avoid introducing biases in the statistics (e.g. one geographic area or one social group being significantly under-represented). Similarly, the geographic distribution of telecommunication operators' customers must also be sufficiently well understood as different operators often hold very different market shares in each region or province.
- Establishing data access protocols with several telecommunication operators or ensuring sufficient representativeness of the data if working with only one operator is complex.
- Fragmented capacities and mandates create challenges regarding the use of mobile phone data. For instance, an NSO might have the capacity to process large amounts of data but lack both domain-specific knowledge of mobile phone data and a mandate to negotiate with telecommunication operators. At the same time, while the information and communication technology ministry (ICT) might have such a mandate, it may lack the technical expertise to facilitate data exchange and processing.
- Most NSOs have the right to access data only from public authorities. Gathering data from private sector sources could require specific legislation.
- NSOs may lack the required technical and human capacities, such as encryption and anonymisation, to securely process massive amounts of data.

Drivers

Many experiments have been conducted worldwide that provide valuable lessons and methodologies to build upon. These include NSOs in Estonia and Indonesia (UNSD, 2019[39]) and COVID-19 analytics in Ghana (Li, 2020[40]), among others.

This data source responds to the need for very specific and timely-limited analyses. Analysis of mobile phone data, for instance, has allowed the Ghana Statistical Service to analyse and visualise the effects of mobility restrictions due to COVID-19 (Ghana Statistical Service, 2021[41]). The analysis provides national decision makers with extremely specific information that traditional methods, such as surveys, could not have provided in such a short time frame. Conclusions included the following:

- Relative changes in mobility (travel within regions, distance travelled, number of locations visited) were generally of larger magnitude than changes in presence, indicating that subscribers altered their daily mobility but did not necessarily relocate as the result of the lockdown and subsequent recovery. However, there appear to have been some relocations (migrations) related to seasonal, cyclical patterns and perhaps other factors, with regions appearing to gradually gain or lose subscribers from September 2019 to January 2021. […] As people begin to return to their pre-pandemic movement patterns, the increased exposure raises challenges in containing the pandemic. This increased risk of infection reinforces the urgency of a successful vaccination campaign and for the public to continue to follow the COVID-19 protocols (Flowminder, Ghana Statistical Service and Vodafone Foundation, 2021[42]).
- The broad array of statistics that can benefit from mobile phone data can generate long-term economies of scale (e.g. several statistics produced on the basis of one data source versus multiplying surveys).
- Partnerships with telecommunication operators can drive digital transformation and the use of mobile phone data for official statistics. Mobile phone operators may see many benefits to such partnerships, among them the production of insights and statistics that they might currently not be legally allowed to compute themselves, new government-to-business partnerships, and benefits to their image and public relations.

4.3. Organisation and processes

Data and information flows

Barriers

- The lack of unified resources, processes and policies to store and manage data, information and knowledge, can lead to a widespread scattering of information sources (across media, repositories, servers, systems, computers, etc.), hindering the digital transformation. Those data and information silos need to be reunited and consolidated prior to building complex and comprehensive digital systems (e.g. data warehouses, complex and cross-sectoral analytical applications, dissemination portals). While technological tools will ultimately enable such consolidation, clear organisational rules and processes are prerequisites without which even the best technologies will be helpless.

Drivers

- The global official statistics community has worked together to develop several models and standards[2] formalising the good practices related to the general and specific statistical processes, including the Generic Statistical Business Process Model (GSBPM), geospatial GSBPM and the Generic Activity Model for Statistical Organizations (GAMSO); information modelling such as the Generic Statistical Information Model (GSIM) and data and production architecture including the Common Statistical Data Architecture and the Common Statistical Production Architecture). Implementing these standards in an NSO implies a deep rethinking and restructuring of the way the NSO functions, which will also trigger specific discussions and decisions pertaining to the way the NSO harnesses the digital world. For example, in GAMSO, the activities “manage IT”, “manage data suppliers”, and “manage information and knowledge” are obviously related to the way digital tools, processes and competencies are implemented in the NSO. In this sense, GAMSO is a good candidate for structuring the first steps of an NSO’s digital transformation because it would force the NSO to explicitly evaluate, discuss and address elements across the four dimensions. Implementing GSIM at a technical level, on the other end, cannot be easily done without a solid

pre-existing methodological and digital infrastructure (databases, metadata systems, the NSO's own data models, etc.).

- Piloting cross-sectoral statistics (e.g. environmental accounting) can very quickly reveal the extent to which the data sources are scattered and, in the worst case, duplicate or contradict one another. Such a pilot can facilitate mapping of the data sources and data flows and help identify priority areas for data integration.

Data security

Barriers

- Ensuring data security is one of the central mandates of NSOs. But a weak institutional understanding of the ICT good practices regarding the security of data can lead to counter-productive policies, decisions and practices. For instance, storage of data on local servers (as opposed to storage in the cloud) is sometimes considered safe because the data are physically stored within the country/territory - on the NSO premises - although a non-mature NSO's IT infrastructure might actually suffer from many security weaknesses, putting data integrity at risk. Similarly, a lack of appropriate data security policies (and, in some cases, inefficient technological tools) may leave NSO staff tempted to exchange data files as email attachments using their personal email addresses, thus making the data actually transit through servers and cloud infrastructures that are located in third-party countries and thus also jeopardising the data's security.

Drivers

An ICT strategy integrating a strong and pragmatic data security concept can lead, at least partially, to the identification and implementation of effective data security measures. However, such a concept should be realistic and implementable in light of internal constraints such as available technologies and tools, digital competencies, etc. Forbidding the usage of personal email accounts, for example, only makes sense if NSO staff have access to a robust corporate email infrastructure. A data security concept must, therefore, be anchored in the reality of the NSO (as opposed to exclusively based on the industry best practices). It further must be understood as an evolutive document that will be regularly adjusted to the reality of the NSO's digital transformation by explicitly integrating security aspects related to the new tools, technologies and approaches that are gradually being deployed. Given the very nature of the data at stake, a data security concept for NSOs also directly impacts data privacy, as defined by the 6th of the Fundamental Principles of Official Statistics ("Individual data collected by statistical agencies for statistical compilation, whether they refer to natural or legal persons, are to be strictly confidential and used exclusively for statistical purposes.") or by the OECD Privacy Framework.[3]

4.4. System and/or environment

Financial resources

Barriers

- All the NSO representatives interviewed emphasised that a chronic lack of sustained and dedicated financial resources hinders them from implementing their digital transformation. Institutional budgets are not sufficient to sustain a working IT infrastructure, while external funding often focuses on pilot activities or on particular sectors and time frames.

Drivers

- Though an ICT strategy cannot overcome all the challenges raised by insufficient financial resources, it can at least provide a coherent framework to avoid the duplication of resources and promote synergies (e.g. sharing technical infrastructure and software licenses across projects, statistics and departments). Especially in the case of low and middle-income countries, which largely rely on external funding to support their digital transformation, a clear ICT strategy can help guide and co-ordinate donors' interventions, thus reducing overlaps and increasing the value for money of this assistance. At a higher level, integrating the NSO's ICT strategy with the strategies of other ministries and state institutions can also help identify cost-saving measures such as pooling of financial resources (e.g. to procure a server, a floating software license or training that is of interest for more than one institution).

Co-operation and partnerships

Barriers

- Co-operation with other state institutions (e.g. with mapping authorities when implementing geospatial approaches) is often challenging due to a lack of institutional agreements and policies, especially pertaining to data exchange or implementation of data standards.

Drivers

- Active co-operation and partnerships with external stakeholders can play an important role in sustaining data ecosystems by making partners accountable to each other. Relevant partnerships could include those between NSOs and:
  - policy units of line ministries (as data users)
  - universities and training institutions (for talent acquisition and to contribute to the capacities of the next generations of statisticians)
  - the private sector (for specific expertise).

Data culture, data usage and data demand

Barriers

- A weak data-use culture can hinder the adoption of modern digital technologies and approaches (Hammer, Ottaviani and Kumar, 2021[43]). Systematic use of data and data-based insights can contribute enormously to improving human and environmental systems. However, the transformative power of data and statistics can only be leveraged if a broad data use culture ensures that they are systematically and correctly understood, interpreted and taken into account in decision-making processes. Strengthened data literacy (in the political sphere, in the media and among the general public) that fosters increased awareness of the hidden power of data can help NSOs better advocate for their own modernisation and digitisation.

Drivers

- The increasing demand for multi-sectoral frameworks and statistics (for Sustainable Development Goal monitoring, for example) requires NSOs to bring together and harmonise data from various organisations. Responding to this demand can foster the development and implementation of integrated data ecosystems, including standard data models, interoperability, advanced technologies to process disparate and massive data sources, quality insurance, etc.

Institutional framework

Barriers

- National/territorial legal frameworks are often quite restrictive in terms of how national/territorial data must be handled. But often not well adapted to the new data protection challenges raised by big data and cloud computing. For example, NSOs are often required to physically store their data within the country/territory, which hinders the usage of cloud computing even when in-country computing capacities do not allow for the efficient and safe storage and processing of big datasets. Moreover, large-scale clouds often offer a level of security that is completely unreachable for most NSOs (UNSD, 2021a, p. 429[18]).
- Given the institutional and organisational prerequisites and implications of a digital transformation, weak institutional leadership can become an insurmountable bottleneck. Top NSO management must provide clear direction and commitment and encourage a broad, positive mindset and attitude towards change. In this way, the leadership can help break old habits and ways of working to overcome individual and institutional inertia.

Drivers

- Governments and decision makers are asking for more timely, more disaggregated and more specific data and statistics, giving NSOs a clear justification for requesting the necessary support for their digital transformation.
- Some NSOs are taking up a new inter-governmental role as data stewards, becoming the key facilitator for data quality, data standards and data-based digital transformation within government organisations. Through this new role, NSOs are able to directly and proactively influence high-level digital policies and priorities that, over the long term, will provide them with more robust framework conditions for their own digital transformation.

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Notes

[1] For an overview of other technologies directly relevant for the digital transformation of NSOs, see chapter 14 at https://unstats.un.org/wiki/display/HSO/Full+Handbook+v2.3.

[2] For additional information, see https://statswiki.unece.org/display/hlgbas/High-Level+Group+for+the+Modernisation+of+Official+Statistics.

[3] https://www.oecd.org/sti/ieconomy/oecd_privacy_framework.pdf.