

Modernization of National Statistical Organization (NSO) Business Processes Using GIS

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Contents	Page
Background.....	1
NSOs' Key Business Processes.....	1
Trends in Business Processes.....	2
Impacts of Technology	4
Emerging Challenges to Business Processes	4
Integrated Solutions for Censuses and Surveys	5
Justification for Modernization.....	5
Spotlight on Field Data Collection: What Is Survey123 for ArcGIS?	6
Recommendations for the 2020 Round of Population and Housing Census	7

Modernization of National Statistical Organization (NSO) Business Processes Using GIS

Background

Traditional national statistical organizations (NSO) have experienced remarkable transformations in the last two decades. Recent advances in information technology protocols have changed how routine business processes such as survey design, data capture, data processing, and to a large extent data dissemination, are being carried-out. The NSOs have also had to deal with the protracted issues of data integrity and data comparability. The emerging issues of restructuring NSO business processes to match the evolving needs of data users in terms of timely release of accurate, reliable, and acceptable survey and census results are key. These herculean challenges may be ameliorated if NSO business processes are seamlessly integrated using state-of-the-art technology inherent in geographic information system (GIS) technology. This paper presents a sustainable approach to the modernization of NSO business processes using GIS.

NSOs' Key Business Processes

Most NSOs today follow a version of the Generic Statistical Business Process Model (GSBPM). Why do we need or use this model? It helps define and describe the statistical processes in a coherent way and standardize processes, allowing us to then compare or benchmark. It also helps inform decisions on systems, architectures, and resources that organizations will need to conduct a census.

Planning/Pre-enumeration			Enumeration		Post-enumeration/Dissemination		
Quality Management / Metadata Management							
Specify Needs	Design	Build	Collect	Process	Analyse	Disseminate	Evaluate
1.1 Identify needs	2.1 Design outputs	3.1 Build collection instrument	4.1 Create frame & select sample	5.1 Integrate data	6.1 Prepare draft outputs	7.1 Update output systems	8.1 Gather evaluation inputs
1.2 Consult & confirm needs	2.2 Design variable descriptions	3.2 Build or enhance process components	4.2 Set up collection	5.2 Classify & code	6.2 Validate outputs	7.2 Produce dissemination products	8.2 Conduct evaluation
1.3 Establish output objectives	2.3 Design collection	3.3 Build or enhance dissemination components	4.3 Run collection	5.3 Review & validate	6.3 Interpret & explain outputs	7.3 Manage release of dissemination products	8.3 Agree an action plan
1.4 Identify concepts	2.4 Design frame & sample	3.4 Configure workflows	4.4 Finalise collection	5.4 Edit & impute	6.4 Apply disclosure control	7.4 Promote dissemination products	
1.5 Check data availability	2.5 Design processing & analysis	3.5 Test production system		5.5 Derive new variables & units	6.5 Finalise outputs	7.5 Manage user support	
1.6 Prepare business case	2.6 Design production systems & workflow	3.6 Test statistical business process		5.6 Calculate weights			
		3.7 Finalise production system		6.7 Calculate aggregates			
				6.8 Finalise data files			

GSBPM v.5.0, Released December 2013

Today, geography plays an integral role across many of these processes, from creation of basemaps to enumeration area (EA) design through data collection, validation, and dissemination. Maps have played a key role in understanding and disseminating information in the NSO for decades. That role has expanded tremendously, consistent with the modernization of GIS technologies.

Trends in Business Processes

There have been many changes in statistical business processes over time. The trends in NSOs' business processes in the past two and half decades, especially in developing countries, can be summarized as follows:

S/N	Key NSO Business Processes	1990–2000	2001–2010	2010–Present
1	Needs Specification	National Priorities	Alignment of National Priorities with International Development Goals	Streamlining and Joint Programming of Multisector Needs; Demand for Small-Area and Disaggregated Data; Demand for More Current Data, Real-Time Demands
2	Survey/Census Design, Baseline Data, and EAs	Traditional Sampling Design	Transformation of Paper-Based Sampling Frame to Electronic Formats	Establishment of Seamless and Geocoded National Sampling Frame; Integration of Remote-Sensed Data; Leveraging Other Authoritative Data Sources; Changing Paradigm of Data Gathering
3	Formulate and Pretest Design	Traditional Household Listing, Pretesting, and Pilot Testing of Census and/or Survey Instruments	Structured Sampling of Households, Pretesting of Census and/or Survey Instruments, and Pilot-Testing of Data Processing Technology	Purposeful Sampling of Households Based on Uniquely Defined National Sampling Frame (EAs); Pretesting and Pilot-Testing of All Facets of Census/Survey Instruments, Procedures, and Field Operations through Data Dissemination
4	Data Collection	Traditional House-to-House Canvassing of Paper-Based Census and/or Survey Questionnaires	Combination of de facto and de jure Data Collection Strategy Using Paper-Based Census and/or Survey	Selective Use of State-of-the-Art Technology for Data Collection; Georeferenced Data Collection to Buildings/Household Levels; Electronic Data Collection and

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		and Forms	Questionnaires and Forms	Transmission via the Internet
5	Data Processing	Traditional Data Processing Using Manual Data-Entry Tools	Combination of Manual Data Entry and Electronic Scanning Technology	Integration of Scanning and Machine Intelligent Data Capture Technologies; Innovative Transfer of Mobile Electronic Data into Master Data Files with Automated Preemptive Data Quality Checks and Data Cleaning Applications
6	Data Analysis	Traditional Data Analysis (Cross-Tabulation) Based on Objectives of Census and/or Survey	Multisector Analysis of Census and/or Survey Data Based on National Priority Themes	Multisector Thematic Analysis of Census and/or Survey Data Linked to National and Sustainable Development Goals; Needs of Citizen and Private Sector; User-Friendly Data, Easier to Understand and Generate Reports and Maps
7	Data Dissemination	Publication of Hard-Copy Census and/or Survey Results as Tables and Reports in Volumes	Publication of both Hard-Copy and Electronic (on CD) Census and/or Survey Results as Tables and Reports in Volumes	Trends in the Reduction of Hard-Copy Publication of Census and/or Survey Results as Tables and Reports in Volumes, Resulting in a Significant Increase in Electronic Dissemination of Census and/or Survey Results Using Web, Cloud, and SMS-Based Technology
8	Data Archiving	Dumping of Confidential Hard-Copy Questionnaires and Forms into Storage for 10 Years	Cataloging of Confidential Hard-Copy Questionnaires and Forms into Storage for 10 Years	Scanning, Cataloging (with Metadata) and Archiving of Confidential Census and/or Survey Data in Electronic Repository
9	Data Evaluation	Traditional Post-Census and/or Survey Evaluation Methodologies	Traditional Post-Census and/or Survey Evaluation Methodologies	Increasing Real-Time Census and/or Survey Monitoring (Command and Control Systems, Dashboards) Using Web and SMS-Based Technology; Increased

				Demand for Historical Comparisons and Need for Baseline Data to Use in Monitoring of Sustainable Development Goals (SDG)
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Impacts of Technology

Technology advances in cloud, mobile, and web GIS are moving NSOs beyond traditional mapping and data collection processes. Web GIS is evolving quickly, bringing opportunities for improvements in efficiency as well as effectiveness. That is realized in cost reductions and time savings and supports options for open, accessible, and secure data, as government policy mandates.

Just as GPS revolutionized data collection, NSOs are being transformed by cloud, smart mobile devices, and apps that consume web maps and services. As noted above, a decade ago, some NSOs still conducted a census or field survey using paper maps and survey tools. Today, those same agencies are having to consider which new technologies to adopt to modernize their processes.

Cartographic, GIS, and other geospatial advancements (GPS, UAVs), along with improvements in satellite, aerial, and other remotely sensed data, have substantially impacted considerations in planning as well as collection and dissemination.

NSOs can collect and manage their systems of record in innovative ways, producing new information products like web maps and web services in addition to traditional maps and data.

Emerging Challenges to Business Processes

Along with advancement come both opportunity and challenges for NSOs due to the changes in business process and emerging trends impacting the industry.

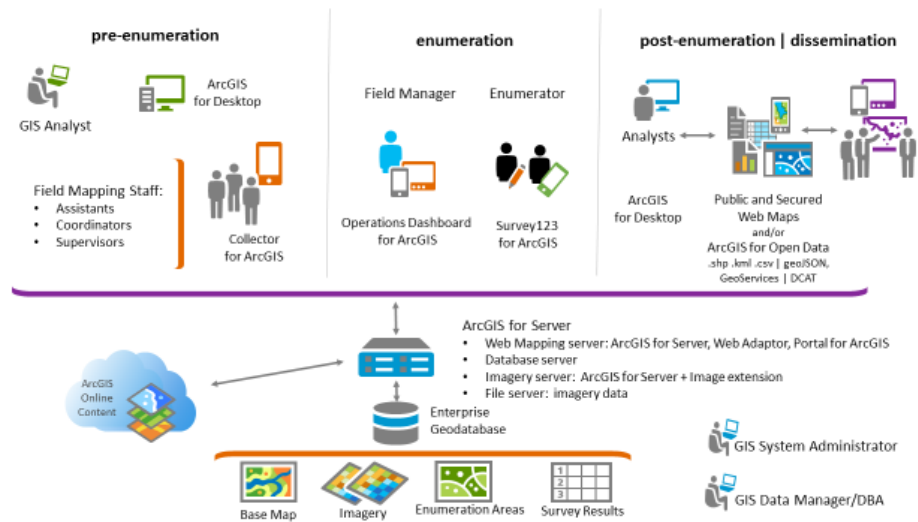
Developing new systems may mean altering the traditional organization of the NSO. Many organizations will be concerned with capacity building, the ability to reorganize and adopt new methods, and change management. Additionally, security and privacy of data are of concern, from collection through the entire data chain including processing and dissemination. The perceived cost/benefit of leveraging other technologies, such as the cloud, may need to be understood along with security needs. Other technical issues will also need to be assessed such as mobile needs, offline, recharging in the field (solar/battery), and general connectivity. Finally, training in all areas of the business process should be considered. That could mean the need for more skilled staff with the expertise needed to perform specific tasks or in modifications to the training programs (train-the-trainers).

As leaders of the NSO, this is where your opportunity lies. These challenges can be addressed with modern technology, proper planning, governance, and vision. Educating existing staff on modern technologies can help ensure your organization has well-trained, dedicated staff who are prepared to embrace the future with you and help in the modernization efforts.

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Integrated Solutions for Censuses and Surveys

An integrated solution for censuses and surveys combines the power of geospatial and statistical data and allows access from any device, anywhere, anytime—a true interoperable system. Government agencies, citizens, and researchers alike will use statistics to make decisions, improving lives and access to services or transforming your economy. NSOs need to put science to work to ensure accurate data collection and access to those official statistics. With ArcGIS® software, you can build maps using up-to-date data, perform deep analysis, and share your results where they'll have the most impact.



Example Architecture Leveraging Modern GIS Technologies

Justification for Modernization

The benefit of moving to modern systems can be categorized in two ways—efficiency and effectiveness.

- Efficiency in the amount of output per unit, cost savings, productivity gains, time savings, increased accuracy, better products, and better service
 - Time savings include the following:
 - ◆ Reduction in time needed to create basemaps
 - ◆ Reduction in time to create EAs
 - ◆ Reduction in time necessary to conduct fieldwork
 - ◆ Reduction in time needed to conduct quality assurance (QA) and quality control (QC) checks
 - ◆ Reduction in time required for data processing
 - ◆ Reduction in time it takes to publish final data and make available for access
 - Cost savings include the following:

- ◆ Reduction in staff needed to field-verify EAs
- ◆ Optimized field work force for collecting data
- ◆ Optimized efficiencies in other expenses such as fuel
- ◆ Reuse of digitized basemap data and maps; geodatabases leveraged across multiple activities (agriculture, business census)
- Improvements in accuracy can be obtained in many areas including the following:
 - ◆ Improved accuracy of address/location due to use of new technologies—leveraging GPS on devices
 - ◆ Improved accuracy of survey data due to use of technology (capture once digitally, no need for manual data entry or scanning) and reduced number of touches on the data
 - ◆ Improved accuracy of survey data due to use of paradata from device
 - ◆ Improved accuracy by utilizing real-time operations monitoring during the enumeration process
- Effectiveness can be seen in improved analytics, data sharing, and societal benefit:
 - Foundational data layers created, such as demography and administrative boundaries, shared among many users, eliminating the need for duplicative costs or efforts
 - Capability to meet demand for georeferenced small-area population data
 - Capability to meet demand for disaggregated statistical data
 - Ability to deliver data more rapidly
 - Ability to ensure security and privacy of data as required
 - Shared best practices

In summary, improvements in the business process will result in reliable, accurate data that is accepted as authoritative by the users.

Spotlight on Field Data Collection: What Is Survey123 for ArcGIS?

Surveys, forms, polls, and questionnaires are really just the same thing: a list of questions. Questions, however, are one of the most powerful ways of gathering information for making decisions and taking action.

Survey123 for ArcGIS is a lightweight, simple, yet powerful data gathering solution that makes creating, sharing, and analyzing survey data possible in just three steps. You can design surveys that include advanced logic and branching, embed audio and images, and use multiple languages. Survey123 for ArcGIS is compatible with the XLSForm specification.

Survey123 for ArcGIS is a simple, form-centric data collection GIS app. Using ArcGIS, you will be able to log in to the app and download any forms that have been shared with you. Once a form is downloaded, you will be able to start collecting data. The application works both online and offline.

Online

- You can sign in and download new surveys.
- You can submit completed surveys.

Offline

- You can keep filling out the downloaded surveys.
- You can save it as a draft and complete it later.

If working offline, your completed forms will be saved locally. When connected, you can submit the data back to ArcGIS.

A key issue with survey data is security. At Esri, security is always of paramount importance (please see trust.arcgis.com). Survey123 leverages Esri's secure ArcGIS platform. The platform enables NSOs to leverage the required GIS capabilities with the assurance that Esri continues to follow a robust and effective security framework. Alternatively, you can also host Survey123 for ArcGIS in your own IT infrastructure with ArcGIS for Server and take full control.

Since Survey123 is built into ArcGIS, you can directly manage and analyze the results of your surveys in ArcGIS for Desktop, ArcGISSM Online, or any ArcGIS app with just a few clicks.

With good people and the use of relevant apps, a simple configuration, and a digital geodatabase, NSOs can develop a sustainable approach to modernization of business processes using GIS.

Recommendations for the 2020 Round of Population and Housing Census

The 2020 round of the Population and Housing Census will definitely provide a landmark transition platform for NSOs to adopt innovative technologies that will strengthen and enhance all facets of their business processes. Esri recommends that the NSOs leverage the ArcGIS platform to become more efficient, improve effectiveness, and increase communication and collaboration.

Esri strongly recommends that NSOs initiate the process of collecting data using the pretested mobile and electronic data capturing potential inherent in applications such as Survey123. This application is efficient, reliable, and accurate and provides cost and time savings for censuses and surveys. The Esri[®] ArcGIS platform integrates seamlessly with census mapping, census/survey enumeration, and data analysis phases. The challenges that NSOs face in monitoring censuses and/or surveys can be significantly improved utilizing the Esri Operations Dashboard for ArcGIS application. This application offers

real-time monitoring and command and control mechanisms, ensuring seamless coordination of field operations, logistics, and communications for censuses and/or surveys. ArcGIS offers a genuine platform for census geography, census locational intelligence, census enumeration area mapping, census geodata collection, query, manipulation, processing and dissemination.

By using state-of-the-art technology inherent in a GIS, an NSO can not only meet but also exceed the needs of the organization and the society it serves.



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