# The Effect of Using New Technology and Geographic Information System on The Quality of Official Statistics: The Implementation of The General Palestinian Census 2017 as a Case Study

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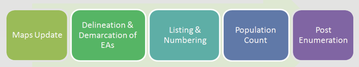
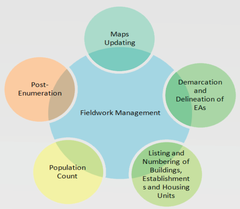
The 2017 Population, Housing and Establishment Census of Palestine was implemented with an integrated electronic system composed in total of six applications for tablets supported with GIS synchronized via WI-FI or SIM Card with dedicated servers based at the PCBS Headquarters. Tablets were used for spatial data editing and census data entry, and for evaluating coverage and data quality after the completion of the census enumeration. The different field activities were monitored centrally from the PCBS Headquarters and at the governorate level by a coordinator and IT specialists that supported the operations on the ground. Digital high-resolution aerial photos updated to 2016 were accessible on-line and off-line from the tablets through these applications as base maps.

## The Overall Census Activities

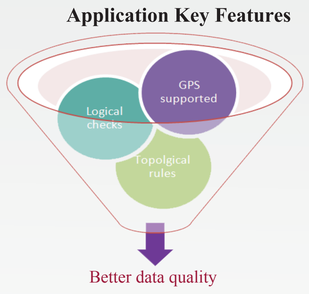



The integrated system included specific applications regarding each phase of the overall census activities.




It considered all the relevant aspects that are necessary for a qualitative census operation, in terms of both, methodological and operational requirements, as internationally recommended. The applications developed included not only the required tools and functionalities for building a comprehensive census infrastructure for mapping, design of questionnaires, numbering and household listings, field enumeration and management, data processing and tabulation, evaluation, data dissemination. It considered also quality control measures and quality assurance tools in each of the census phases and applications.

### Application Key Features



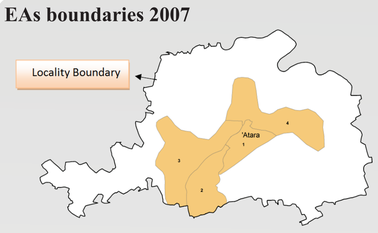

## Preparation phase

The total area covered in the 2017 census of Palestine was 6,025 km², comprising 5,660 km² in the geographic region of West Bank, and 365 km² in the geographic region of Gaza Strip. As a first-order administrative division, the territory is divided into 11 Governorates in the West Bank Region (Jenin, Tubas and Northern Valleys, Tulkarm, Nablus, Qalqiliya, Salfit, Ramallah and Al-Bireh, Jericho and Al-Aghwar, Jerusalem, Bethlehem, Hebron), and 5 Governorates in the Gaza Strip Region (North Gaza, Gaza, Deir Al-Balah, Khan Yunis, Rafah). Regions are divided into Localities, which are inhabited places usually with a Local Administration.

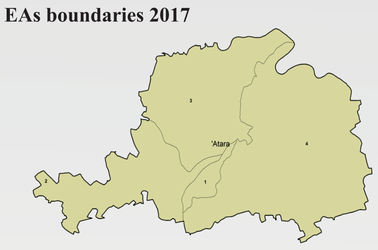
### Palestine Map


According to the 2007 census, there were 557 Localities. During the preparation phase, the Census National Committee established for the 2017 census, composed of representatives of PCBS, Government Ministries, research institutions and from the civil society, revised the boundaries and number of the Localities, resulting in a total number of 613. These changes were reported in the Administrative Classification Manual. Following the revised manual, the boundaries of administrative units were recorded in the PCBS geodatabase using GIS tools, and the census geography was appropriately re-defined.
The localities of 2007 census covered only the inhabited areas, which were then divided into enumeration areas (EAs) based on several criteria. After viewing the international recommendations which state that maps must cover the overall areas of the country -inhabited and uninhabited areas - the boundaries of the EAs were Extended through the ArcGIS Desktop software in order to cover all uninhabited areas.

### EAs boundaries 2007




### EAs boundaries 2017

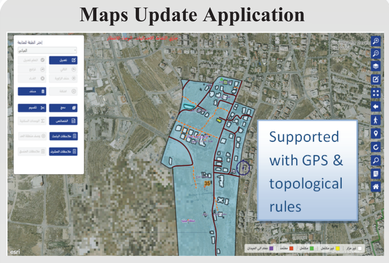



## Maps Update

Maps updating was carried out by a field team of approximately 312 field surveyor, each surveyor was assigned between 20 to 25 EAs and their work was coordinated by a supervisor assisted by a Director in each Governorate. EAs were revised taking into consideration all the geographical features (such as roads, streets, pathways, barriers, Israeli expansions and annexation walls, and Israeli settlements) through adding, deleting or modifying buildings, landmarks, building characteristics (such as the number of floors or the number of housing units) in a way that match the reality on the ground. This data was then used to finally define the boundaries of the EAs, by modifying their shape or splitting them or creating new EAs when deemed necessary.

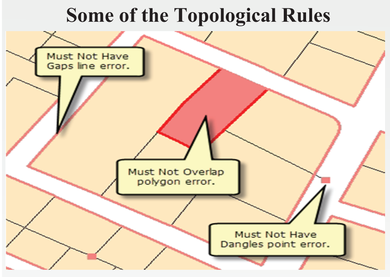
Surveyors checked in the field all the boundaries and edited those when necessary using the application of maps update supported with aerial photos of 2016 on tablets synchronized with the geodatabase at PCBS premises. This application included a set of logical rules that improved the quality of the map updating operations. For instance, surveyors were not able to access other areas than the ones assigned to them or were not allowed to edit buildings located to more than 25 meters from their position (their location was monitored through GPS functions).

### Maps Update Application




Using maps update application, surveyors could select different GIS layers to edit (layer on buildings, layer on streets, layer on landmarks), and within each layer each spatial feature could be visualized with a different color or texture according to its characteristics (for example: by type of edit such as new, modified, deleted buildings; by type of building such as intended for residential or business use; or by number of housing units included in the buildings, etc.).
By the end of maps update phase, an updated geographic database was obtained and submitted to many topological rules such as EAs mustn't overlap and shouldn't have any gaps between them in order to be used in the delineation of 2017 EAs, during which 2017 localities were re-divided through the Administrative Classification Manual into EAs areas based on the updated geographic data, where each EA contained about 150 - 180 housing units.

### Some of the Topological Rules




## Demarcation & Delineation of EAs

The supervisors (fieldworkers of this process) delineated and demarcated the enumeration area on the ground and placed delineation marks on the outer walls of buildings within the external boundaries of the enumeration areas. As such, the external boundaries of the enumeration areas were matched to the electronic maps uploaded on the tablets, taking into account to provide supervisors with certain flexibility to enable them modify the starting point or external boundaries of some enumeration areas to ensure that the situation on the ground matches the electronic maps uploaded on the tablet. During this phase, all the 6,831 enumeration areas defined previously in 2017 geodatabase (with the exception of Area J1 in Jerusalem Governorate with 463 enumeration areas which done by using paper maps) were delineated and demarcated covering all localities in the West Bank and Gaza Strip.

The use of technology along with GIS in the pre-enumeration phase has improved and facilitated the field operations during the data collection phase. However, it should be noted that the modification of the boundaries of the EAs used for the 2007 census were not always recorded in the geodatabase as paper maps were used and all the geographic figures were updated manually, as for the delineation of enumeration areas it becomes more accurate by 2017 census as the induction of the boundaries of enumeration areas on the ground is better than 2007, especially in the remote areas through the use of GIS technique.

## Data Collection Phase

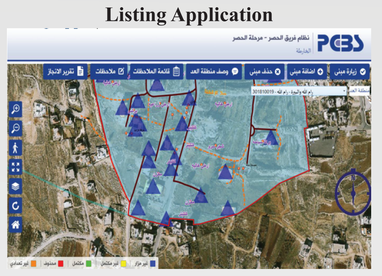
The key applications included in this phase were the listing application, designed to fulfill the needs of the questionnaire of buildings and housing units, and the establishments questionnaire with their logical checks, the counting application that was designed for the households and housing conditions questionnaire with its logical checks. Also, the fieldwork management application that was designed for monitoring of field workers achievements through using Global positioning System (GPS) as a tracking system.

## Listing and Numbering of Buildings, Housing Units, and Establishments

During this process, every building was marked and classified as census (population and establishments) and non-census building (such as buildings used for agriculture or for storage purposes) using a special application uploaded into the tablets and synchronized with the central database at PCBS designed for the purpose of listing. The application enables the crew leaders (fieldworkers of this process) to assign unique numbers for buildings, housing units and establishments and collect data on their characteristics based on both building, housing units and establishments questionnaires within each enumeration area.

The listing application was supported with GPS technology in order to ensure that each crew leader will number the right building corresponding to the one on the map where the point of GPS indicates, through a limitation on the distance between the crew leader and the buildings coordinates that guarantees the questionnaire opens on the tablet.

### Listing Application



The application also allowed the crew leader to be on a continuous read with the daily achievement through smart maps for each EA that indicates the status of each building visualized with a different color or texture according to its characteristics, for both the census buildings (visited, unvisited, incomplete, deleted) and the non census buildings.

Also, the application were supported with logical checks regarding listing questionnaire where automatic warning messages pops out on the screen for data wrong entry or when data of different indicators is inconsistent.

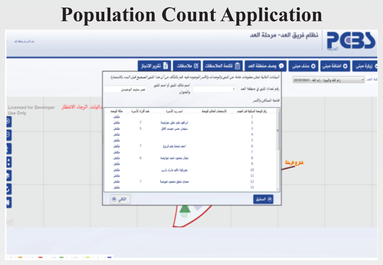

The listing phase comprised an initial framework for the next process, where basic data about housing units and households were loaded to the population count application, such as the total number of housing units inside each building, the total number of households in each housing unit.

## Population Count

This process is considered to be the most important among all census activities as the main aim of the census is to be accomplished by collecting data on housing conditions of households and their different characteristics as well as all members of households covering their socio-demographic and economic characteristics regarding each member.

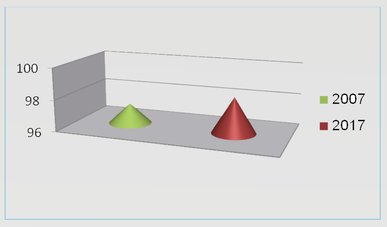
A special application uploaded on tablets was used which included an electronic questionnaire regarding households and housing units directly linked to spatial features representing the place of usual residence of households. This application was supported with logical checks regarding household and housing units questionnaire with automatic warning messages similar to the one used in the listing process that guaranteed a high percentage of data quality.

### Population Count Application



Additionally, the application used allowed the enumerators (fieldworkers of this process) recognize housing units to be visited through GPS techniques along with basic identification data on each building such as (the name of the head of household, building address) in the assigned EA loaded on the application from the listing process, Such quality checks had the advantage of avoiding duplication and dropping any of the housing units. This lead to a higher coverage percentage than 2007 census where enumerators could collect data on the same household twice or drop some of the housing units due to paper maps where the building were sketched manually.
In order to assess the coverage of the main census findings a post enumeration survey has been implemented using a special application right after the population count process was completed. The random sample regarding this survey included 288 enumeration areas covering 4% of the overall EAs, being one enumeration area per every supervision area in the West Bank and Gaza Strip.
In comparison with 2007 the under coverage percentage decreased from 2.7 to 1.7 in 2017.

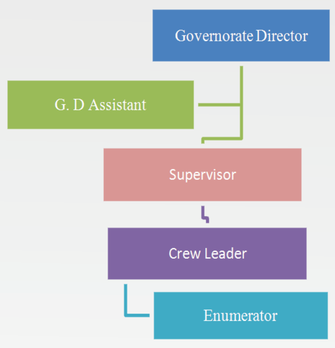
### Percentage of Coverage




## Fieldwork Management

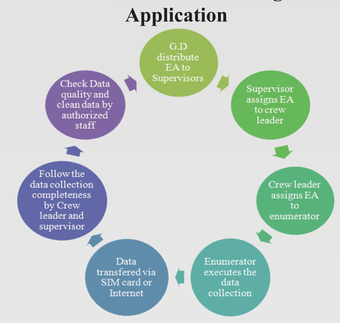
One of the significant arrangements done before implementing the census is performing a profound base in each of the 16 governorates in the West Bank and Gaza Strip. In this context, an organizational structure of the fieldwork was adopted.

### Organizational Structure of the Fieldwork




During each process of the census, there were special applications used by each of the administrative and supervisory levels, supported with GPS that allowed a daily follow up per supervisor, crew leader, and enumerator through a decentralized monitoring. A centralized monitoring was achieved through a central fieldwork operation room performed in PCBS during data collection phase where timely reports on the daily achievements, dilemmas and difficulties from the field are being reviewed.

### Workflow of Feldwork Management Application




The field management application played a key role in data collection phase, especially in population count process. The central fieldwork operation room was able to produce reports on the coverage of the census enumeration and on the performance of field staff in which housing units were enumerated, buildings partially visited, and households interviewed, number of refusals or inhabited units that enumerators could not visit because of the temporary absence of occupants. Such monitoring was based on the data collected during the previous process of the census of buildings and establishments.

### Tracking System of Field Management Application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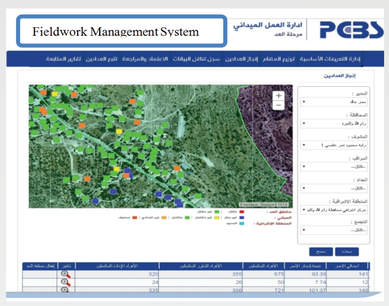
### Coverage Achievements Reports

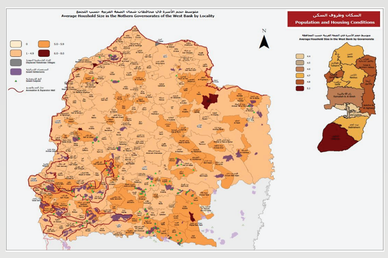



## Data Dissemination Phase

Following the conclusion of the 2017 census field operations, the Preliminary results of the census were published by the beginning of 2018 in a short time as using technology and GIS in each phase mainly saved time and effort. The final findings were published after the completion of census databases and comparisons with previous censuses and surveys for specific indicators and other related estimations such as population projections on PCBS website. Using GIS technology allowed to publish census data on several detailed geographical levels using new techniques.

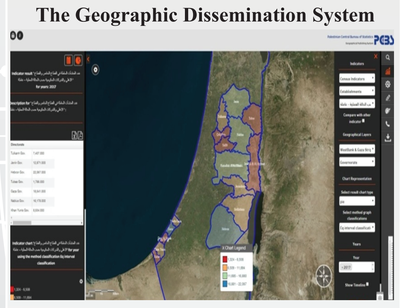
Thematic maps were used in publishing Preliminary results and is being used in each of the published statistical reports or to be published, also such maps are used in the published paper statistical atlas.

### Thematic Maps of The Statistical Atlas



One of the new techniques used during the dissemination phase of 2017 census was the geographic dissemination system that allows data users to get census data as a form of spatial data disaggregated on the locality level, through an interactive map with specified indicators and variables on each statistical topic, where the users can choose the type of data representation on the map in a way that meet their needs.

### The Geographic Dissemination System



PCBS also used Esri platform on SDGs in order to create story maps using census data regarding some of the SDGs indicators. Using this platform allowed to publish 2017 census data using images, videos, interactive maps in a way that make it easier to understand statistical numbers through telling stories for the most prominent issues.

### ESRI Platform of Palestinian SDGs


## Conclusion

It is internationally recognized that the appropriate use of new techniques especially geospatial technology in census operations increases the coverage of the enumerated units (housing units, households, individuals, establishments), improves data quality and timeliness, and reduces the costs of statistical data production in the medium to long-term period, for both censuses and sample surveys.

The quality and coverage accomplished in this census proved the above argument, as PCBS adopted a paperless method for data collection operations compared to the previous census conducted in 2007, with extensive use of GIS and tablets integrated in an electronic system composed of several applications organized in a relational database.

In comparison to 2007 census, both the data collection and data entry phases were reduced into one phase in 2017 census as data was collected and entered at the same time in the field, in consequence, a lot of time and effort were saved.

This poster aims to come up with new recommendations regarding the use of the electronic integrated system developed for the 2017 census for the purpose of conducting of sample-based statistical surveys, and censuses with better data quality and higher coverage rate.

**THANK YOU**