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Census technology, innovation and outsourcing**Census technology: Key results the UNECE Survey on National Census Practices, and first proposals about the CES Recommendations for the 2020 census round****Note by the UNECE Task Force on census technology***Summary*

In early 2013, the UNECE conducted an online survey among its member countries on national practices in the 2010 round of population and housing censuses. This document presents an overview of the main results of the survey (part I) and some first proposals about the preparation of new Conference of European Statisticians Recommendations for the 2020 Round of Population and Housing Censuses (part II), with regard to census technology and related issues.

I. Key results on census technology from the online survey on national census practices**A. The main technologies used in the census****1. Internet response option**

1. Fifty countries responded to the survey question on Internet response, one of which (Georgia) stated that it had not yet decided whether it would use an internet response option (having not yet undertaken its census for the 2005-2014 period).

2. Of the 49 remaining countries, over third (18) provided an Internet response option, and in all but one case (Luxembourg) an on-line questionnaire was used. In 23 countries (47 per cent) the census was conducted without an Internet option, but it should be noted that in eight of the countries (16 per cent) (Austria, Belgium, Denmark, Finland, The Netherlands, Norway, Slovenia, Sweden) the census was completely register-based – in which the use of the internet to collect data was not relevant.
3. In 13 of the 18 countries that had an Internet response option (72 per cent), there was the possibility of choosing between an Internet response option and other data collection methods, such as paper questionnaires, face-to-face interviewing, telephone, etc. The remaining five countries used Internet options as the “sole initial” source of data collection, while other methods were introduced later.
4. Various methods for data quality control and correction of collected data were applied to the Internet response option. Among the most popular methods were: the automated sequencing of relevant questions, interactive editing to reconcile problem entries, and the use of drop-down lists to ensure entries matched valid options. These methods were used in 77 – 89 per cent of countries using the Internet. Occasionally other methods were used such as assisted coding.
5. The most commonly used method of delivering the logins and passwords, needed to access the online form, was by sending these on the paper forms or letters, which were sent to the respondents’ postal address (11 out of 18 countries using the Internet (61per cent)). In two countries enumerators delivered logins and passwords directly to the respondent's postal address. Two countries did not provide logins and passwords – these were defined based on data coming from registers. Six countries used other methods – for example, in Luxembourg persons could only fill in the online census form by identifying themselves via an electronic signature.
6. To ensure the security and privacy of data collected via the internet, different methods were used by different countries, sometimes in parallel. Unique access codes were used by two thirds of countries (13), while personal identification numbers (PINs), which allowed for the form to be completed in more than one session, were reported by seven countries. In six countries, to ensure the confidentiality of collected data, a physically separate infrastructure was used for gathering data from different methods; CAPTCHA¹ for the Internet census was commonly used in five countries, in the attempt to prevent automated software from performing actions which degrade the quality of the online census system.
7. In connection with their Internet response option, countries used several strategies to deal with potential problems connected with the peak demands on their infrastructure. For example, 39 per cent of countries using the Internet encouraged households to complete the forms in the off-peak periods, or used public relations efforts to manage expectations. Six countries (33 per cent) hired external Internet service companies to increase capacity; whereas two countries (11 per cent) limited the promotion of the Internet response option. Other methods for dealing with problems caused by peak infrastructure demands were used in four countries (traffic-directing instructions being sent to users, the number of servers being increased, and the necessity of file liquidation were planned during the building phase for the census infrastructure). No particular strategy was cited to cope with peak demand problems in 28 per cent of responding countries.

¹ Short sequence of keys shown on the screen (or played by the speaker for the audio CAPTCHA), to make sure that it is a human entering data, and not an automatic system such as those used by hackers to attack websites.

8. Use of the Internet in the next round of censuses will certainly become more widely adopted. Some 33 countries (almost double the number in 2010 census round) reported that they are likely to collect data in this way in the 2020 round.

2. Technology used in fieldwork

9. Forty countries responded to a question about technology used for field operation, although most of those using register-based censuses did not. Responding countries used the following technologies for data gathering and field operations:

- (a) Laptops – used by 10 countries (25 per cent) – eight countries used laptops for the first time (20 per cent);
- (b) Tablets – were used for the first time in this round by three countries (7.5 per cent);
- (c) Hand-held devices, pocket computers or smart phones – two countries (5 per cent) – this technology was used for the first time in this census round;
- (d) Mobile phones – nine countries (23 per cent);
- (e) SMS texting facilities – five countries (13 per cent);
- (f) Geographical Information Systems (GIS) – 19 countries (48 per cent), of which 13 (33 per cent) used it for the first time;
- (g) Global Positioning System (GPS) – seven countries (18 per cent), of which six (15 per cent) used it for the first time;
- (h) SMS-texting — eight countries (20 per cent), of which six (15 per cent) used it for the first time;
- (i) Uploading data from field to a data center – 10 countries (25 per cent), of which eight (20 per cent) used it for the first time;
- (j) Computer Assisted Telephone Interviewing (CATI) – seven countries (18 per cent), of which four (10 per cent) used it for the first time;
- (k) Automated telephone interviewing – was used for the first time in this round by one country (2.5 per cent).

10. The survey asked about the technology likely to be adopted in the 2020 round, countries reported that they plan to use the following devices (displayed in Figure 1):

- (a) Tablet computers – 20 countries (43 per cent);
- (b) Laptop computers – 13 countries (28 per cent);
- (c) Hand-held devices/Pocket Computers/Smart phones – 12 countries (26 per cent);
- (d) Mobile or cellular phone – four countries (8 per cent).

and the following technology:

- (a) Geographical Information Systems (GIS) – 37 countries (79 per cent);
- (b) Global Positioning System (GPS) – 16 countries (34 per cent);
- (c) SMS-texting 12 countries (26 per cent);
- (d) Uploading data from field to a data center – 11 countries (23 per cent);
- (e) Computer Assisted Telephone Interviewing (CATI) – seven countries (15 per cent);

(f) Automated telephone interviewing – two countries (4 per cent).

11. Figure 2 shows that of these technologies, the most commonly used in the census was GIS - which was used by 48 per cent countries (of which 33 per cent used it for the first time).

12. In relation to the technology used in 2000 census round, we can observe at least a two-fold increase the number of countries using each of these technologies.

Figure 1

Devices used in field operations

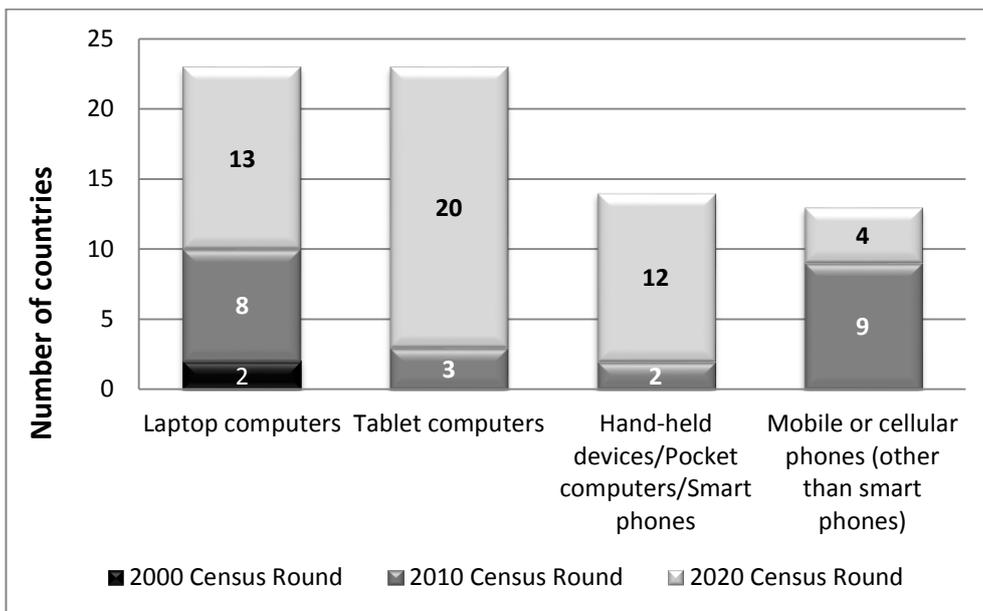
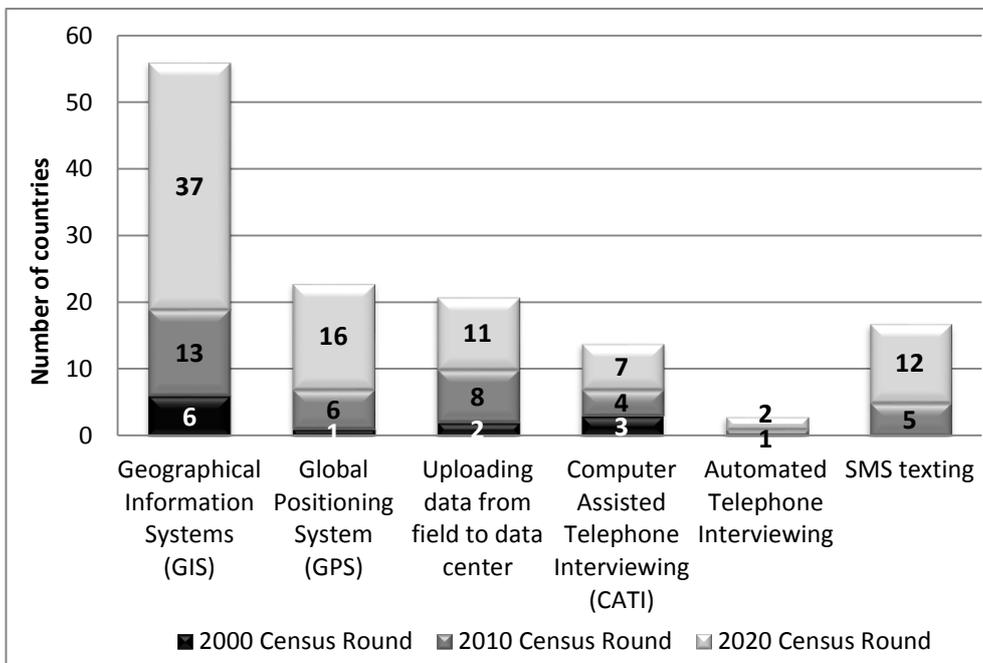


Figure 2

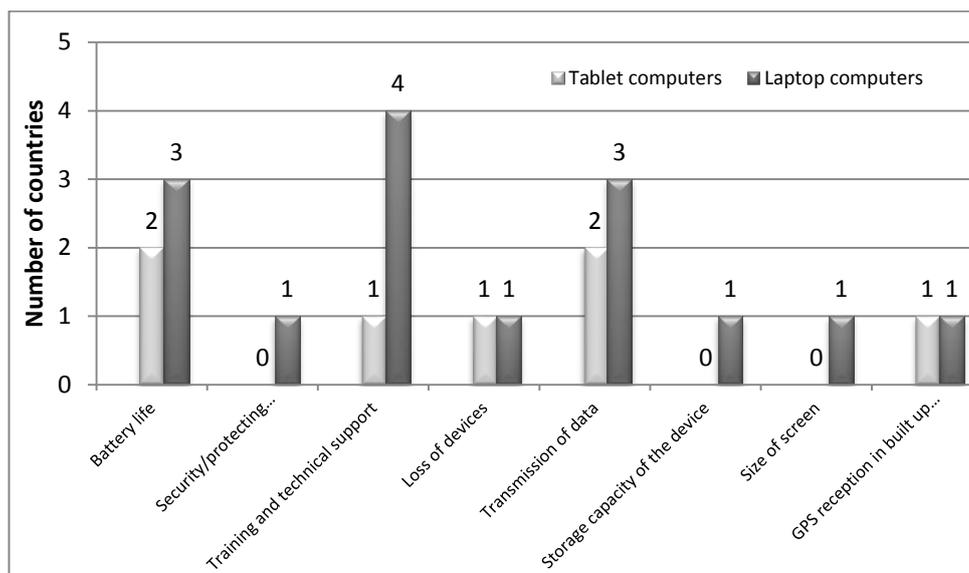
Technology used in field operations



13. The survey asked about problems encountered using devices in field operations, with results presented in Figure 3. The use of tablets and laptops in field operations turned out to be somewhat problematic – 40 per cent of countries using laptops in the census reported at least one problem, and 66 per cent reported problems with using tablets. The most frequently reported problems related to the battery working time and data transmission. Poland and United States of America used hand-held devices during the census, but did not report any problems.

Figure 3

Problems with using devices (tablet and laptop computers)



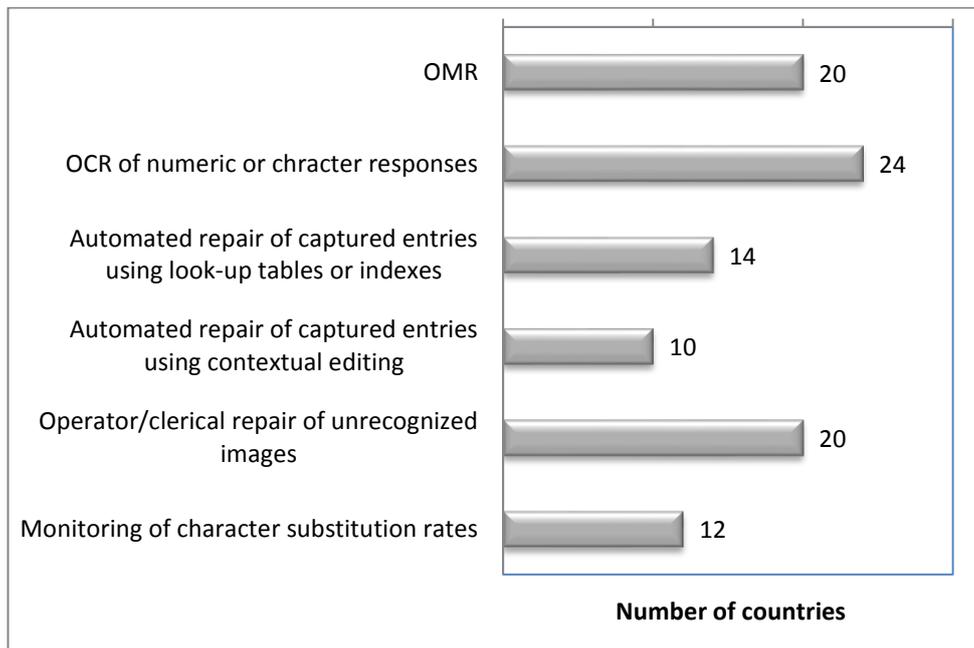
3. Using of OCR/OMR technology

14. The survey asked about the use of Optical Character Reading/Recognition (OCR) or Optical Mark Reading/Recognition (OMR) technology in the 2010 census round, with the results displayed in Figure 4. About 24 countries (65 per cent) used this technology. Among these countries, 20 used the OMR, and 24 the OCR. Countries where the census was completely register-based are not included in the category of 'responding countries' and are thus not included in the denominator for the percentage response figures.

15. In those countries using OCR/OMR technology, 17 (70 per cent) used methods for automated repair of captured entries using look-up tables or indexes, or used automated repair of captured entries using contextual editing. Twenty countries (83 per cent) used operator/clerical repair of unrecognized images.

16. In thinking about the technology likely to be adopted in the 2020 round, only 19 countries reported that they plan to use OCR and even fewer, 14, plan to use OMR. This would represent a declining trend in the use of such technology.

Figure 4
Use of OCR/OMR technology

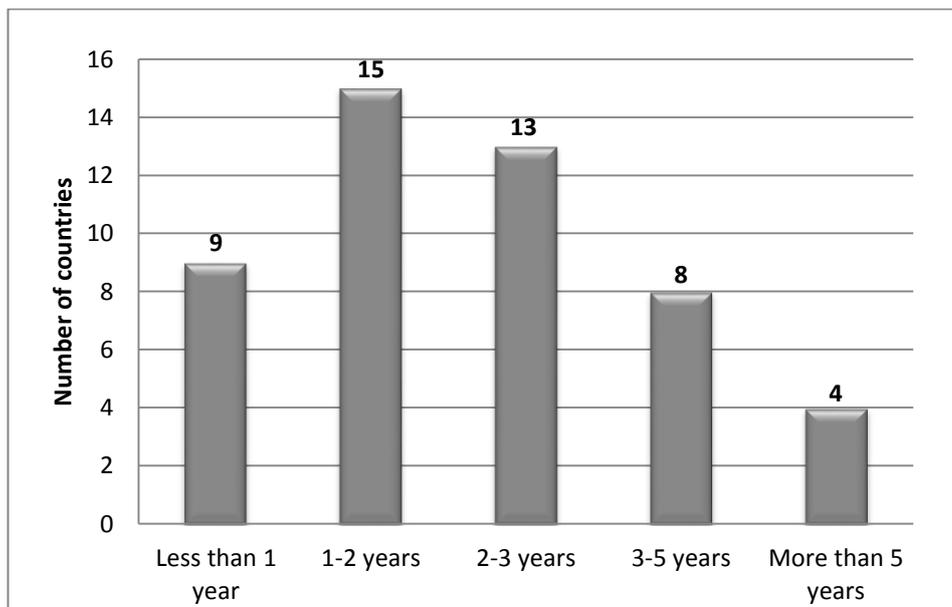


4. Infrastructure

17. One of the most common elements of the preparatory work for the census was preparing the appropriate IT infrastructure.

18. Regarding the amount of time required to prepare the IT infrastructure (Figure 5), the majority of countries needed no more than three years. Only four countries needed more than five years for this task.

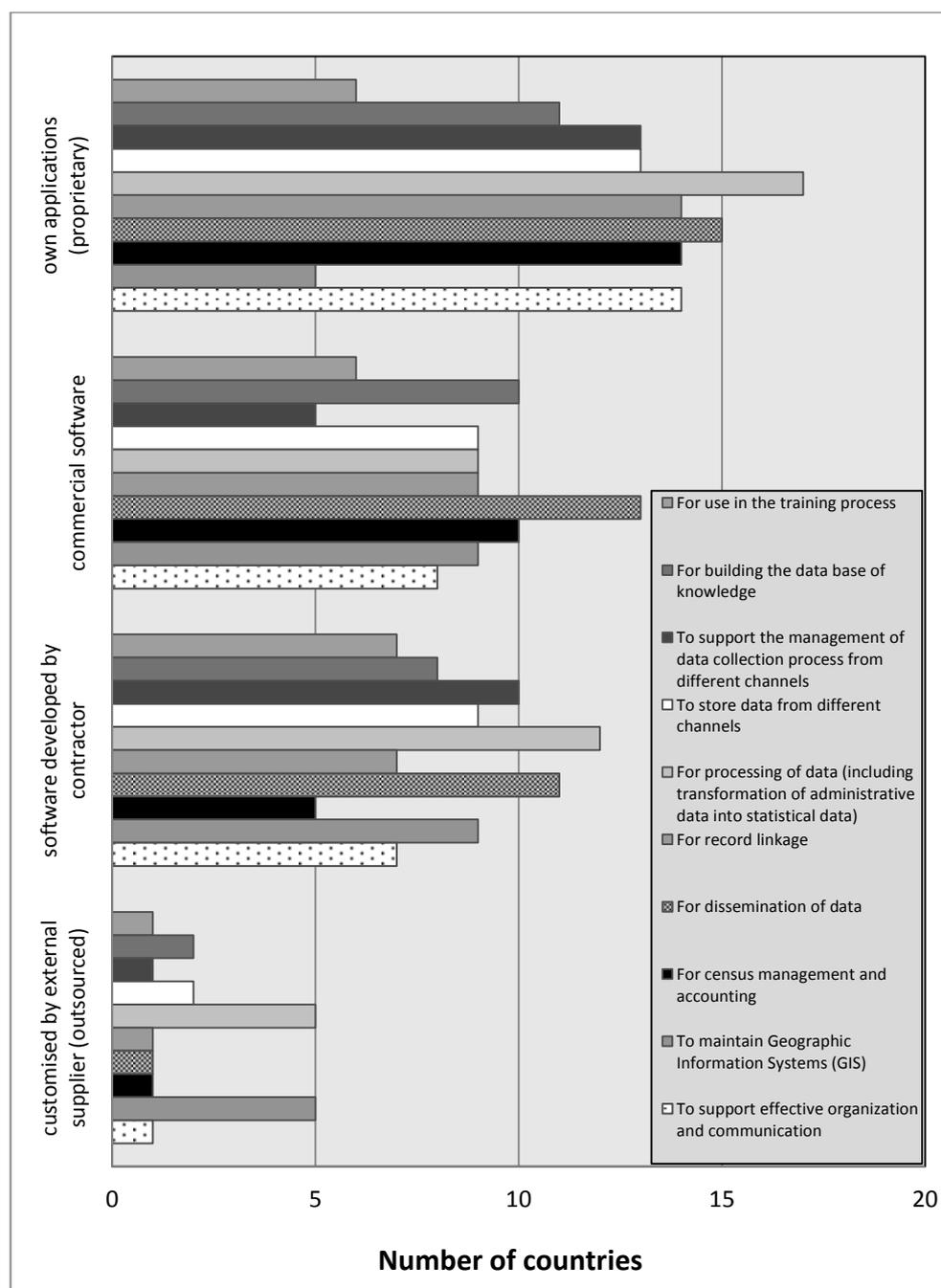
Figure 5
Duration of infrastructure preparations



5. Software

19. Software applications were used for different purposes while conducting the census. For most purposes, more countries used their own applications than used commercial or other software. Another group of countries used commercial software and software created by external contractors. Open source software was used only for certain purposes, and only in isolated cases (five countries). A breakdown of software application use, by kind of application, is presented in Figure 6.

Figure 6
Software used in different census phases



20. We can observe that most countries used their own applications for purposes associated with collecting, storing, processing and dissemination data (about 13-17 countries). For most of the purposes detailed in Figure 6, commercial software and software developed by contractors were used by less than 10 countries.

21. Software customized by external suppliers was used especially for dissemination of data and to maintain Geographical Information Systems, but otherwise was only used in isolated cases.

22. It is worth noting that many countries reported that they did not use any application:

- (a) to support effective organization and communication between the various participants in the process – 17 countries (35 per cent) did not do so;
- (b) for use in the training process – 26 countries (55 per cent);
- (c) for building the data base of knowledge – 13 countries (29 per cent);
- (d) to support the management of data collection process from different channels – 16 countries (35 per cent);
- (e) to maintain Geographic Information Systems (GIS) – 17 countries (38 per cent).

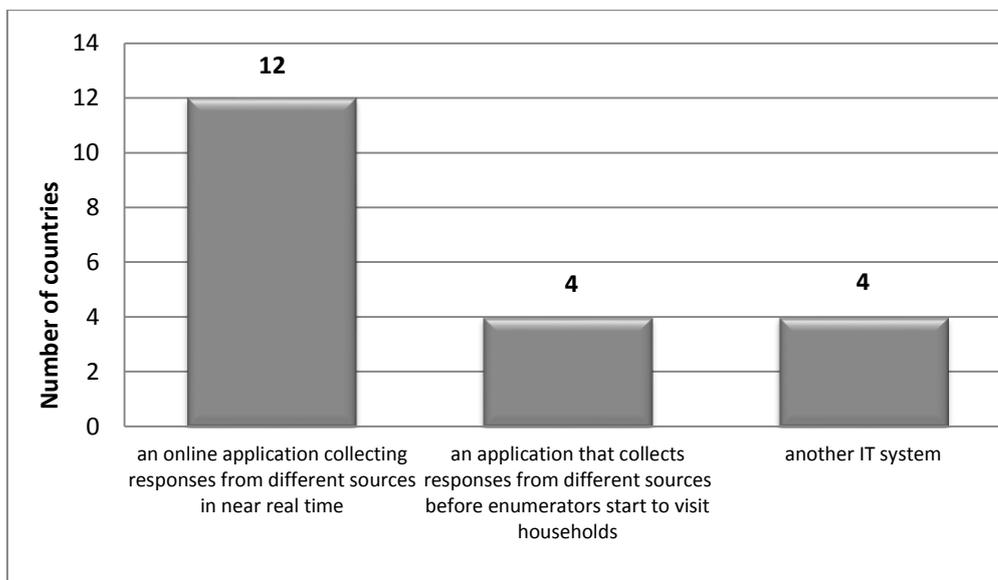
23. Only 27 per cent of the countries utilized special technology to allow the participation of people with physical disabilities in the census.

24. It is worth noting, that the "friendly" form with Braille language was adopted by some countries. In some countries, sign language interpreters were involved during the interview for the deaf and persons with difficulty of hearing.

25. The additional facilities for people with physical disabilities were not used very often during the 2010 Census Round. However, it was reported that user-friendly technologies will be more widely used in the future.

Figure 7

IT systems used to manage different sources of census responses



26. The survey asked about IT systems used in the 2010 census round, with results displayed in Figure 7. Twenty countries used IT systems in the 2010 census round, to manage census responses from different sources (i.e. enumerators, Internet response, mail). Twenty-nine countries did not use an IT system for this purpose because of not using an Internet response option.

B. Technologies used for administrative sources of data

27. The survey asked countries to report if they used data from administrative registers, and what techniques they used. Figure 8 shows the results.

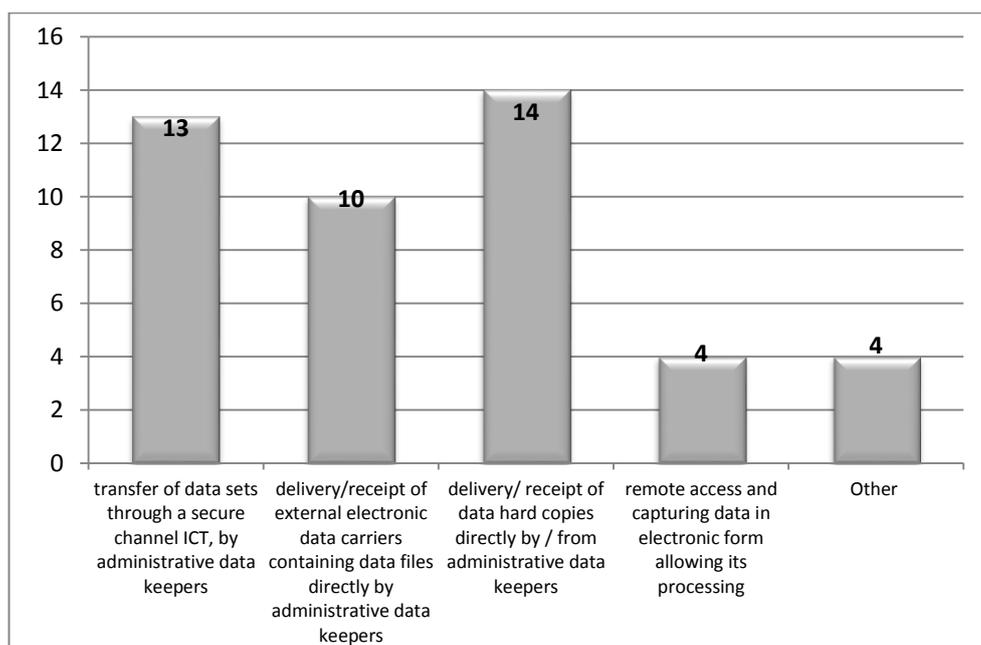
28. Forty-nine countries responded. Nineteen of these (39 per cent) did not use administrative registers for census purposes, while 30 countries (61 per cent) did so, of which:

(a) Thirteen countries used data from administrative registers using the technique of transferring data sets through a secure channel ICT, by administrative data keepers;

(b) Ten countries used data from administrative registers using the technique of delivery/receipt of external electronic data carriers, containing data files directly by administrative data keepers;

Figure 8

Techniques used to employ data from administrative registers



(c) Fourteen countries used data from administrative registers using the technique of delivery/ receipt of data hard copies directly by/from administrative data keepers;

(d) Four countries used data from administrative registers using the technique of remote access and capturing of data in electronic form, allowing its processing;

(e) Four countries used data from administrative registers using other methods.

29. Different techniques were used to collect administrative data. There were often complex methods, often using multi-modal approaches, to collect data from such registers.

Out of 30 countries that have taken data from registers, we have the following frequencies of number of techniques used:

<i>Number of techniques used</i>	<i>Number of countries</i>
4	1
3	3
2	8
1	16
0	2

(a) Only Slovenia indicated using all four of the techniques, that had been detailed in this question, for using administrative register;

(b) Three countries (Iceland, Poland and Belgium) reported the use of the following three techniques for using administrative data;

(i) Transfer of data sets through a secure channel ICT, by administrative data keepers

(ii) Delivery/receipt of external electronic data carriers containing data files directly by administrative data keepers

(iii) Delivery/ receipt of data hard copies directly by / from administrative data keepers,

(c) Eight countries reported the use of two techniques of administrative data taking;

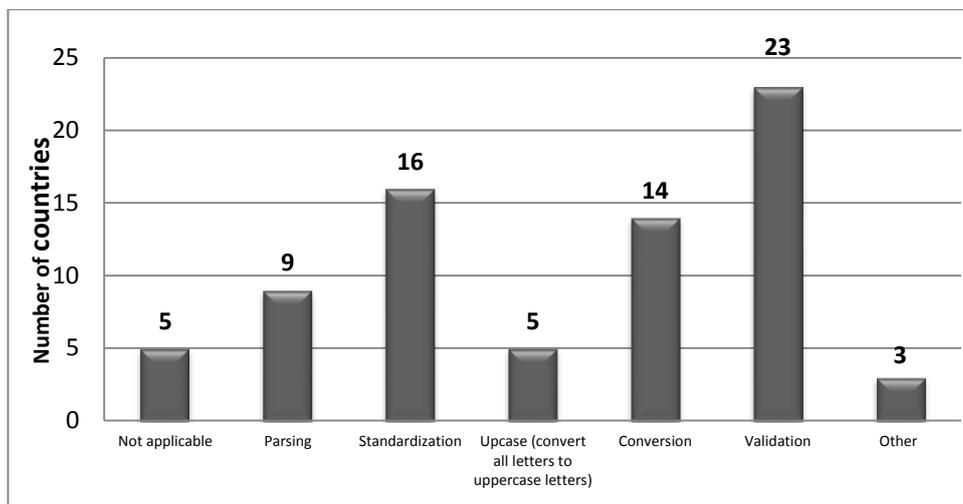
(d) Most - as many as 16 countries, indicated the use of one technique for administrative data taking;

(e) Two countries reported the use of data from registers, but they indicated no technique for data taking. They specified in comments, for example, that internally-held administrative sources had been used, or that data from administrative registers had already been collected for purposes other than Census 2011.

30. The survey asked countries to report if they used any methods to transform administrative data into statistical data. Figure 9 shows the results.

Figure 9

Methods used to transform administrative data into census data



31. Twenty-two out of 51 countries did not respond to the survey question, most of which used a traditional census method.

32. The validation method was the main method that was used to transform administrative data into statistical data. This method was applied by 23 countries. In addition:

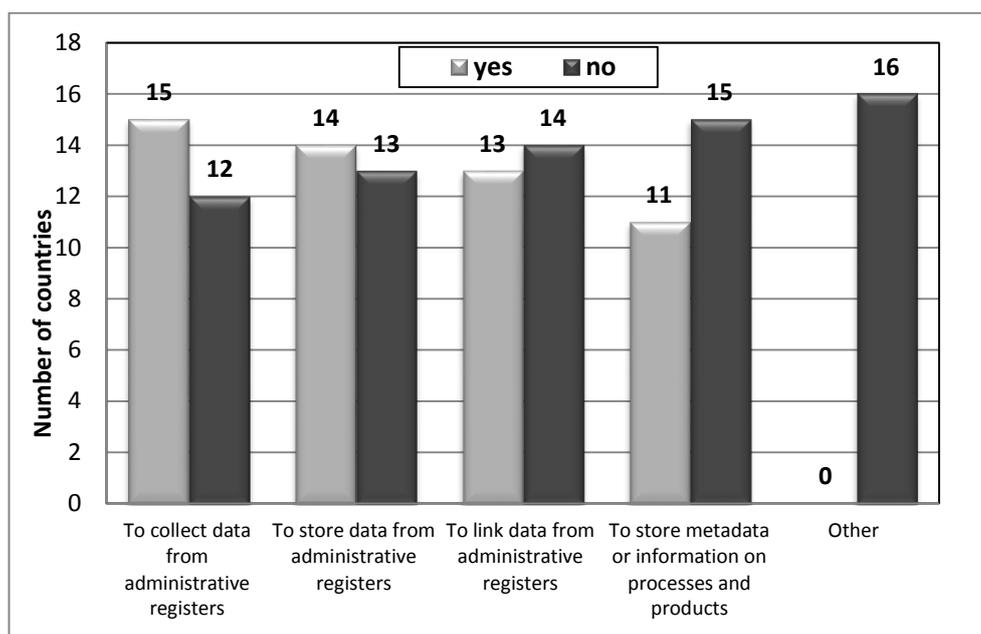
- 16 countries applied standardization
- 14 countries applied conversion
- nine countries applied parsing
- five countries applied uppercase (convert all letters to uppercase letters)
- three countries applied other methods
- three countries applied all the methods listed in response options
- six countries applied a combination of four methods, mostly excluding uppercase.

33. These figures indicate an increasing use of automatic cleaning, standardisation and data validation techniques. It should be a guideline for the forthcoming round of censuses.

34. Countries that used administrative data were asked if any hardware-system-utility infrastructure had been constructed or modernized to transform the data. Figure 10 shows the results.

Figure 10

Infrastructure construction/modernization for data transformation



35. Out of 27 responses, the following reasons were given for why hardware-system-utility infrastructure was constructed or modernised:

- to collect data from administrative registers (15 countries)
- to store data from administrative registers (14 countries)
- to link data from administrative registers (13 countries)
- to store metadata or information on processes and products (11 countries).

36. One country did not construct the infrastructure just for census purposes but for the statistical processes in general before the 2011 census.

37. Seven countries constructed/modernised hardware-system-utility infrastructure for all of purposes listed in the response options.

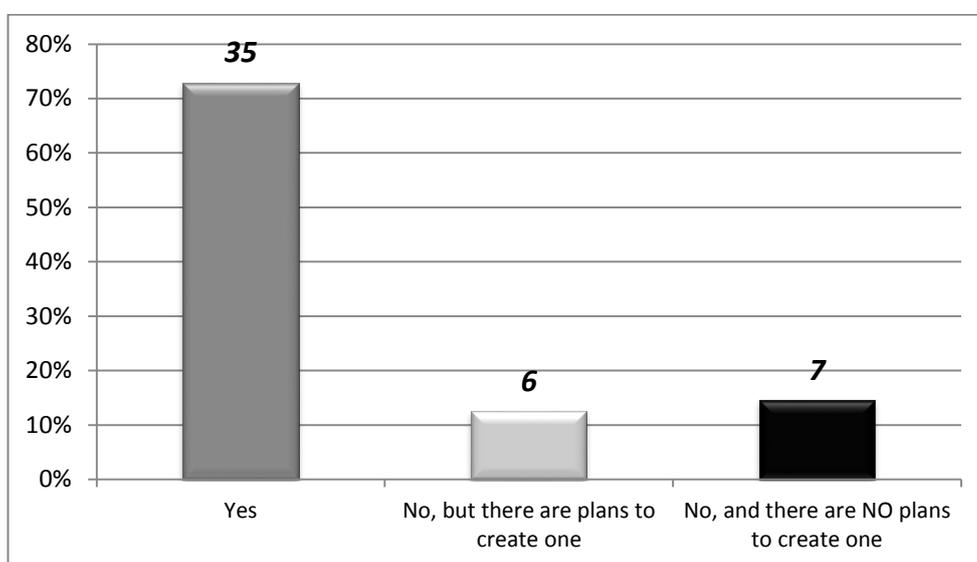
C. GIS technology

38. Taking into account answers provided by the countries participating in the survey, there is a strong and growing interest in the use of GIS as a tool to support the process of conducting the census, and as a tool for friendly visualization of statistical results.

39. The survey asked countries to report if a unit responsible for GIS technology existed in their National Statistical Institute, with the results presented in Figure 11.

Figure 11

Presence of a GIS unit within the NSO



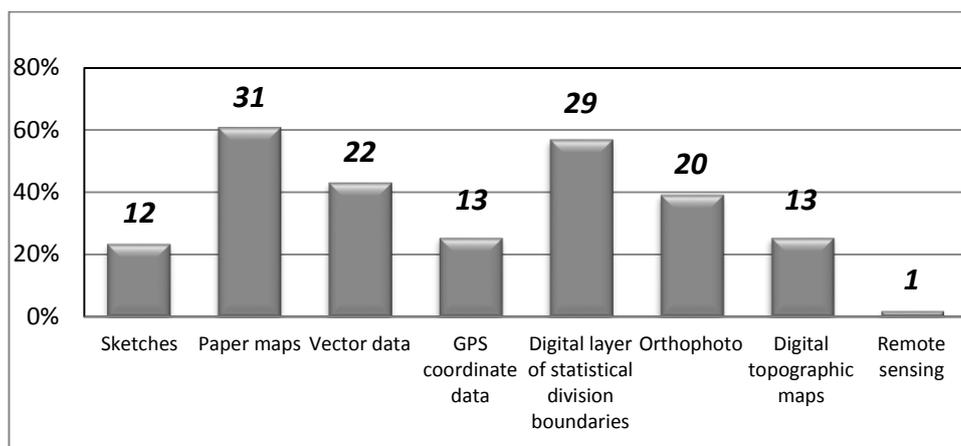
40. Figure 11 shows that a significant majority of countries implement GIS technology in their National Statistical Institute. Thirty-five out of 48 countries (73 per cent) declared that a unit responsible for GIS technology has already been formed. A further six institutions already have future plans to establish such a unit. Seven countries do not intend to create one.

41. The survey also asked what type of geographic data was used in the various phases of the census, with results displayed in figure 12.

42. From Figure 12, we can see that cartographic materials are widely used in various stages of the census. Thirty-one out of 48 countries (65 per cent) reported the use of paper maps in at least one of the census' stages (42 per cent of the countries use paper maps during census preparatory works, while 52 per cent of the countries use them to coordinate and monitor enumerators).

43. Use of vector data and digital statistical division boundaries is also popular. Twenty-one countries used one or the other of these during census preparatory works. Thirteen countries used them to coordinate and monitor enumerators. Vector layers are also used in 15 countries either to perform analyses or for census results' dissemination.

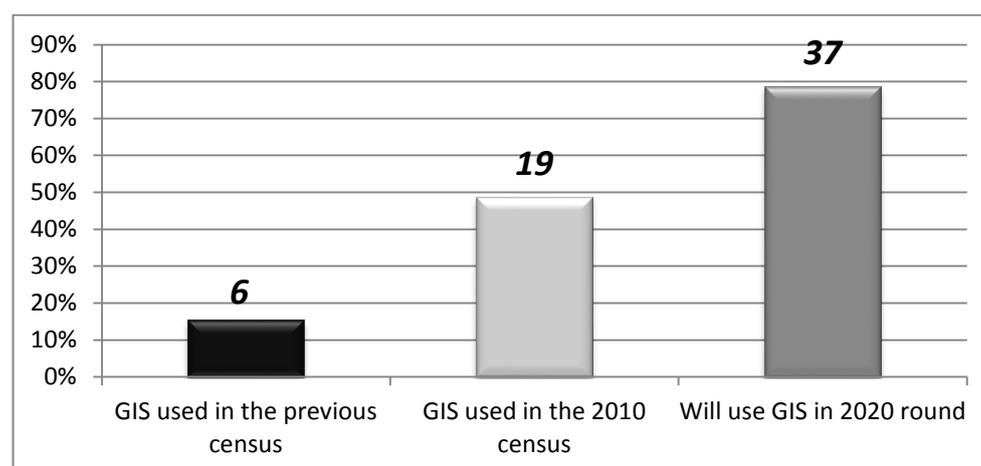
Figure 12

Type of geographic data used at least in one phase of the census

44. However, there was little use of remote sensing, as only one country declared using this technology for data analysis.

45. The survey specifically asked if Geographical Information Systems (GIS) were used for field operations, with results presented in Figure 13.

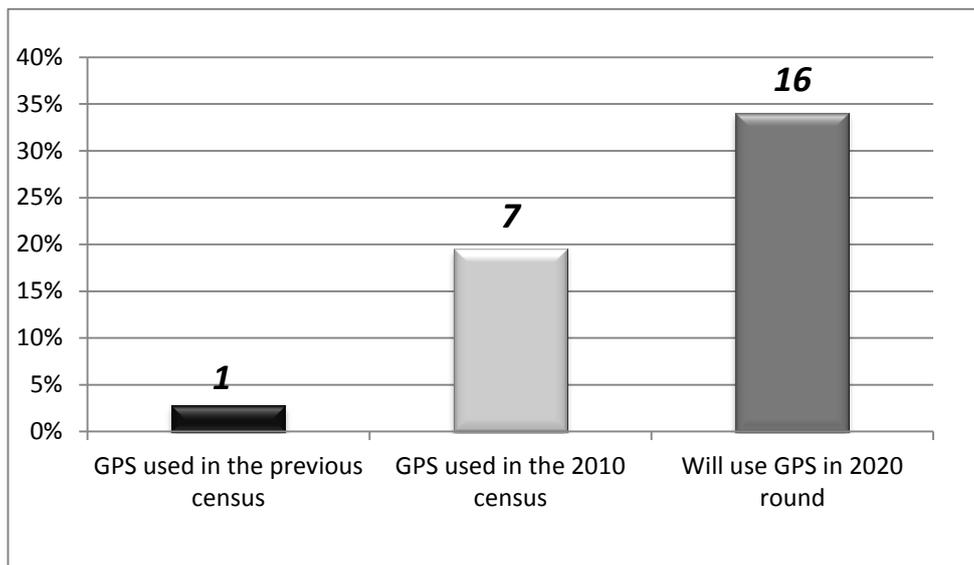
Figure 13

Use of GIS in census field work

46. Figure 13 shows an upward trend in the use of GIS technology in census field works is clear. According to the survey conducted in 2013, in the 2000 census round this technology was used in approximately 15 per cent of countries, while in the 2010 round almost 50 per cent of countries decided to use it. For the 2020 census round, 76 per cent of countries plan to use GIS. In addition, two countries have declared that despite the fact that GIS was not used in census field works, this technology was used during census preparation. Almost 50 per cent of countries reported GIS as an innovative technology supporting the census, almost 25 per cent of the remaining countries plan to expand the use of GIS in the coming 2020 census round (see also the paper on Innovations, ECE/CES/GE.41/2013/5).

47. Countries were also asked if they used a Global Positioning System (GPS) for their field operations, with results presented in Figure 14.

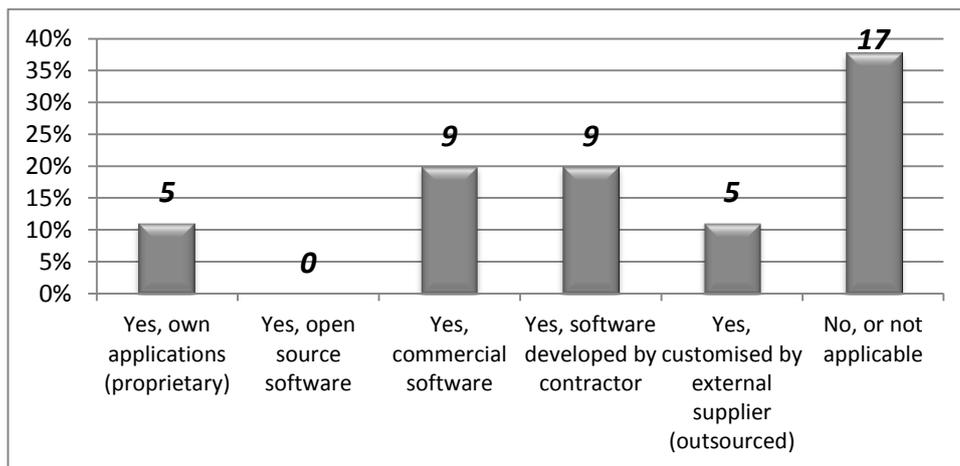
Figure 14
Use of GPS in field operations



48. Figure 14 displays a similar trend with regard to the use of GPS as a support for field works. According to the survey conducted in 2013, in the 2000 census round only one country opted for its use, while in the 2010 census seven countries used GPS, with the trend mirroring the increased popularity of GPS in recent years, in various spheres of activity. Interest in GPS technology has grown similarly. For the 2020 census round, 34 per cent of countries plan to use GPS. Thirteen per cent of countries indicated GPS as an innovative technology used in the 2010 census. Fourteen per cent of remaining countries plan to develop this technology in the next 2020 census round (see also the paper on Innovations, ECE/CES/GE.41/2013/5).

49. Countries were then asked if they used software applications to maintain their Geographic Information Systems (GIS), with results presented in Figure 15.

Figure 15
Use of GIS software



50. In Figure 15, we see that 28 of the responding countries declared that they maintain some form of geographical information system. Most countries use commercial software for this purpose (ready-made or developed), and five countries use self-built applications.

Despite its wide availability ‘open source’ software was not used for this purpose. Four countries did not provide an answer to this question, although they declared that a unit responsible for GIS technology exists in their National Statistical Institute.

51. GIS technology is also widely used for the publication of census results. Twenty countries reported that they use GIS web-based mapping tools to disseminate census results.

52. Considering the results presented in Figure 13, it can be observed that there is a strong upward trend for broader use of GIS technology in censuses.

D. Plans for the 2020 census round

54. The paper has already reported briefly on countries’ plans for their use of technology in the 2020 census, particularly with respect to the use of the Internet, OMR/OCR, GIS and GPS.

55. As detailed in Table 1, other technologies, that countries reported that they would consider using in the next round, included tablet computers (reported by 20 countries), laptop computers (13), and other hand-held devices such as pocket computers or smart phones (12). All of these would be used in the collection of information from field operations, so it is not surprising that no register-based country reported such usage.

Table 1

Technology planned to be used in the 2020 census round

<i>Kind of Technology</i>	<i>Count</i>	<i>Count EEA countries</i>	<i>Count non EEA countries</i>
Internet response option	33	19	14
Laptop Computers	13	9	4
Tablet Computers	20	9	11
Hand-held devices/Pocket Computers/Smart phones	12	9	3
Mobile or cellular phones (other than smart phones)	4	3	1
Geographical Information Systems (GIS)	37	23	14
Global Positioning System (GPS)	16	8	8
Optical Character Reading/recognition (OCR)	19	9	10
Optical Mark Reading/recognition (OMR)	14	7	7
Computer Assisted Telephone Interviewing	7	3	4
Automated Telephone Interviewing	2	1	1
Big data (information from credit card companies, cellular phone suppliers, Google, etc.)	9	8	1
Internet exploration	5	3	2
SMS texting	12	8	4
Uploading data from field to data centre	11	5	6
Other	4	4	0
None of the above	4	3	1

56. Only 10 per cent of countries are not planning to use technology that was used in the 2010 census round, especially the following technology:

- BLAISE software
- paper questionnaires
- personal telephone interview, using paper questionnaire
- Optical Character Reading/recognition (OCR).

57. Some countries are planning to change the methodology used in the 2010 census round to be fully based on administrative sources. Moreover, it should be noted that for the 2020 census round, nine countries are going to use Big Data², which reflects a recently emerging trend. This technology allows for collection and analysis of large data volumes in a very short time.

E. Barriers to adoption of new technology

58. Finally, countries were asked what barriers they might expect to encounter in the adoption of new technologies for the 2020 round of censuses. Lack of financial resources was reported by three quarters of all responding countries (37), followed by the related issues of lack of staff resources (30 countries) and lack of expertise (18) (see Table 2).

Table 2

Barriers to adoption of new technology

<i>Kind of barrier</i>	<i>Count</i>	<i>Count EEA countries</i>	<i>Count non EEA countries</i>
Financial Resources	37	23	14
Staff resources	31	19	12
Expertise	19	7	12
Infrastructure	17	9	8
Public perception	15	9	6
Government support	10	5	5
Culture	5	3	2
Geographical conditions	2	1	1
Climate	2	0	2
Lack of administrative registers	17	9	8
Limited access to administrative registers	16	10	6
Other	2	2	0
None of the above	7	5	2

² Very large and complex data collection (I. e. information obtained from credit card companies or cellular phone suppliers etc.) that is difficult to process using on-hand database management tools or traditional data processing applications. due to its size.

II. Proposed changes to the CES Recommendations for the 2020 census round

In this section, some changes to the text on census technology in the CES Recommendations are proposed, in view of the 2020 census round. Reference is made to the paragraph numbers in the CES Recommendations for the 2010 round of censuses. The text on Outsourcing in the 2010 CES Recommendations (paragraphs 112-117) is covered in the separate report on Outsourcing (ECE/CES/GE.41/2013/5). 59. Paragraph 105, first sentence: After "...such as key-entry systems" add "or Optical Character Recognition (OCR)/Optical Mark Reading (OMR) technologies"

60. Paragraph 106: At the end of the paragraph add the following sentence: "International cooperation and consultation would be a good practice in the decision to adopt a new technology."

61. Paragraph 108: After the second sentence, add the following sentence: "Seeking international cooperation and consultation would be a good practice in the decision to adopt a new technology."

62. Paragraph 118: Rephrase as follows: "The following three collection technologies are considered: Internet response option, telephone interviewing, hand held devices e.g. tablet computers, laptop computers, pocket computers, smart phones, mobile, or cellular phone. New technology allows the collection and processing for some steps to be done simultaneously. The opportunities that new technologies offer for managing better the collection operations are discussed. The use of technology in developing the use of administrative register for census purposes is also discussed."

63. Heading above paragraph 119: Rephrased as "Internet response option"

64. Paragraph 120: Replace the text "The use of the Internet is likely to increase the cost of the census, at least initially. As it is not known in advance who is likely to use the Internet, there will be a need to deliver a paper form to every household including those who will subsequently use the Internet." with the following text: "It is worth mentioning that some target groups (e.g. younger age classes in urban areas) may prefer to fill in the forms via the Internet, and therefore delivering the paper questionnaire to such respondents may be unnecessary. It is worth considering therefore only sending out access information to the internet response option."

65. After paragraph 122: Add a new paragraph as follows: "Internet response option requires the provision of credentials to the respondents and methods of delivering the logins and password needed to access the online form which might include:

- (a) posting the paper forms or letters ;
- (b) delivery by enumerator directly to the respondent's address;
- (c) defining the logins and passwords based on data coming from registers. The combination of data typically for the whole population should be used to authenticate the respondent's identity (by using for example a Personal Identification Number).

66. Paragraph 123: Replace the text "How far other editing or on-line coding is built in to the form needs to be carefully considered. Some limited studies indicate that forms returned by the Internet are of higher quality than paper forms. More work is required in this area to determine whether this is a function of the type of people using the Internet or the technology itself" with the following text: "In order to ensure high quality of data collected via the Internet, it is important to provide mechanisms to control errors in the form. Control should be conducted in the real time. The respondent should be able to modify the incorrect data."

67. Heading above paragraph 126: Rephrased as “Telephone interviewing”.
68. After paragraph 129: Add a new paragraph as follows: “Computer Assisted Telephone Interviewing (CATI) method should be used to collect data by the short questionnaires and/or to verify and complete the missing data by the long questionnaires.”
69. Paragraph 132: Rephrase as follows: “Working with hand-held devices should be efficient. Several technical issues need to be considered in using these devices. Storage capacity is related to the cost of the devices, but is of itself not now a limitation on their use. To ensure the safety of data, the forms should be kept in the hand-held devices at the last 24 hours. The length of battery life should not be a problem. If the census enumerators work all day, they will have additional charging source for hand-held devices”
70. Paragraph 133: Delete the following text at the end: “, for example the additional processes that need to be employed when an enumerator forgets their password. It is estimated that these supports costs can be up to four times more than for a similar device used within a controlled office environment.”
71. Heading above paragraph 135: Rephrased as “Census management software”
72. After paragraph 137, add the following six paragraphs:
73. Paragraph 137a): Taking into consideration that census is huge undertaking, it is very important to secure appropriate software to support all the census processes ranging from the training of field staff , the data collection and processing operations and the dissemination of outputs
74. New subheading between paragraph 137a) and 137b): “GIS Technology”.
75. Paragraph 137b): There is widespread recognition that it is important for national statistical agencies to develop a continuing cartographic capability to serve their specialized cartographic needs. It should be stressed that there is now a wide range of techniques and technologies available for use in a census mapping exercise. There is a strong and growing interest in the use of GIS as a tool to support the process of conducting the census (use of vector data and digital statistical division boundaries), and as a tool for friendly visualization of statistical results (GIS web-based mapping tools to disseminate census results). Maps, which are now commonly in the form of digital products, play an increasingly important role in the dissemination phase.
76. Paragraph 137c): GIS as far as it is possible should be used at all stages of the census (inventory preparation, progress monitoring, and dissemination of census results). Despite a significant majority of countries implementing GIS technology in their National Statistical Institute it is still the case that in many countries there are only a limited range of maps available and these often do not show sufficient detail to enable the boundaries of small areas to be clearly defined.
77. Paragraph 137d): GIS technology should be considered only at a level appropriate to the skills and resources available, and constitute an integral part of the overall work of a national statistical organization. Collaborative arrangements with other agencies, such as national mapping and survey agencies, should be pursued particularly with regard to the acquisition and maintenance of base maps and digital databases, which should not become a responsibility of national statistical organizations. Therefore as many administrative sources as possible should be inspected for presence of spatially referenced data and tested for the possibility of using it for statistical purposes.
78. Paragraph 137e): Wherever it is possible, data should be collected with reference to an address point- results can then be disseminated using any desired spatial divisions.

79. Paragraph 137f): A very broad and comprehensive description of the use of maps and GIS technology at all stages of census has been developed in the document "Principles and Recommendations for Population and Housing Censuses, Revision 2" prepared by the UNSD available at

<http://unstats.un.org/unsd/demographic/standmeth/principles/default.htm>. It is highly recommended to use those recommendations- particular attention should be paid to chapters:

- III.A.8 Mapping
- III.F.3 Geographic information systems
- VIII.B Census mapping
- VIII.C Interactive digital outputs.

80. Paragraph 138: Delete the last sentence "These trends are likely to continue."

81. After paragraph 138: Add a new paragraph as follows: "Based on the conclusions from 2010 Census Round , it is likely that more countries will use Internet response option, but some countries will still continue to use paper form and OCR / OMR technology. "

82. In paragraph 142 rephrase the second sentence as follows: "An example of this process is briefly described below. "

83. After the paragraph 156 (at the end of the chapter on technology) add a new section with title " Developing the use of administrative registers in population and housing censuses", with the text presented in the following paragraphs.

84. Paragraph 156a): The development and increase in availability of new information and telecommunication technologies (ICT) for national statistical institutes causes administrative registers to be more and more broadly used in population and housing censuses. The efforts of statistical institutes to make wider use of data from administrative registers in censuses are primarily dictated by the necessity to reduce data collection costs and the burden on respondents. The use of data from administrative registers is particularly effective in statistical institutes where data from registers is used not as part of a single action, but continuously and consistently in many data collection operations for the purposes of various surveys. This issue is important due to the necessity to incur increased expenditure in the initial period, which is needed to use data from administrative registers.

85. Paragraph 156b): The new approaches to statistics production based on multimodal data collection and integration, increasingly frequently used by national statistical institutes, trigger the necessity of creating or modernising a suitable hardware-system-utility infrastructure. The dynamic development of new ICT and their increasingly broad application in statistics production, even in countries with a long-standing tradition of administrative data use in censuses, in the 2010 census round caused the necessity to modernise the infrastructure for collecting, storing and linking data from administrative registers and storing metadata, processes and products. Bearing in mind the development of state-of-the-art technologies and the commitment of national statistical institutes to implement innovative solutions in censuses, in the 2020 census round it will be inevitable to create or modernise the hardware-system-utility infrastructure.

86. Paragraph 156c): Census results are the outcome of the implementation of a large number of processes and sub processes. As the quality of census results largely depends on the quality of these processes, measures should be undertaken to improve the quality of statistical processes by determining and measuring the key variables in the process, i.e. the variables which have the greatest impact on product quality. Process-quality indicators should be used to evaluate the impact of process quality on product quality. The use of the

Generic Statistical Business Process Model (GSBPM) to design, describe, and define the set of statistical processes in the census might contribute to improved census quality.

87. Paragraph 156d): In the census, the data from administrative registers may be used in the following statistical processes

- (a) Designing;
- (b) Data collection;
- (c) Processing.

88. (Paragraph 156e): As part of the preparatory work for the census, in the process of designing, the issues connected with using data from administrative registers should be specified at the stage of designing the data-collection methodology, sampling frame, sampling method, and data-processing method.

89 Paragraph 156f): The availability of identification data from registers for national statistical institutes is growing in importance in connection with the increasingly-used methodology of producing statistics based on numerous data sources. After the administrative registers that can be used in the census are identified, an evaluation of register quality should be performed from the point of view of the planned forms of use and adopted evaluation criteria. Data from administrative registers may be used in the census in a variety of ways:

- (a) As a direct data source;
- (b) To build or update lists and sampling frames for the census;
- (c) For data preparation - imputation, data estimation;
- (d) For the quality control of data from traditional censuses.

90. Paragraph (156g): In assessing the usefulness of administrative registers as direct data sources for the census, the minimum quality criteria should be the completeness, timeliness and methodological compliance of data. An important and frequently-employed form is the use of data from administrative registers to build or update lists and sampling frames for the census. In this case, particular attention should be paid to the completeness, timeliness and ability to identify respective population units in registers.

91. Paragraph 156h): The application of several techniques of collecting data from administrative registers and data from other sources used in population and housing censuses will require a more comprehensive organisation and management processes and more complex systems. New technologies provide opportunities for improvement in this case as well. The process of collecting data from administrative registers should include the preparation of a data-collection strategy using various data-collection modes.

92. Paragraph 156i): In 2010 round censuses national statistical institutes used various methods of obtaining data from administrative registers. The data obtaining process was dominated by electronic data collection:

- transfer of data sets through a secure ICT channel, by administrative data keepers
- delivery/receipt of external electronic data carriers containing data files directly by/from administrative data keepers
- remote access and capturing of data in electronic form, allowing its processing.

93. Paragraph 156j): To obtain data from registers, it is necessary to prepare data-collection methods and provide technical solutions – hardware-system-utility infrastructure. The condition necessary for electronic data collection is the proper infrastructure. A crucial issue connected with the process of data collection from administrative registers is the

protection of data. Regardless of the technology applied, the data collection strategy, often including the entire population, should ensure information security. This issue should be taken into consideration already at the stage of designing the process of obtaining and gathering data from administrative registers and designing a hardware-system-utility infrastructure. A number of technical issues concerning the coding of data transmission should be considered in detail, together with the use of secure transmission channels.

94. Paragraph 156k): In the 2010 census round many countries used various techniques of automatically converting administrative data into statistical data, which in the context of a dynamic development of ICT technologies and a growing quantity and availability of administrative registers for statistical purposes should be taken into consideration in the 2020 census round. During the 2010 census round the following techniques were used: validation, conversion, parsing, standardization and uppercase. With the procedure of automatic data cleaning in place, it is possible to eliminate errors in source data from administrative registers. The use of data cleaning tools makes data editing process efficient. New technologies might prove useful in the process of linking records and data.

95. Paragraph 156l): The quality of source data, including administrative registers, has a large impact on the quality of output data (products). Therefore, the methodology of improving the quality of data from administrative registers, i.e. adjusting them to statistical requirements, is of vital importance. The use of data from administrative registers as a rule requires a more comprehensive preparation than in the case of traditional censuses. State-of-the-art technologies may prove very useful here and have a key impact on improving the efficiency and effectiveness of these operations.

96. Paragraph 156m): In the processing of data from administrative registers, i.e. improving their applicability to censuses as data sources, without the negative impact of the applied sources on the quality of output data, the following elements should be taken into account: the collection transformation model, i.e. the applied set of rules and principles of data control and adjustment reflecting the concept of the required quality level of input data. Moreover, it is recommended for national statistical institutes to prepare descriptions of specific procedures of transforming data from administrative registers and data quality measurements on the basis of the applied scope of validation checks and the agreed principles. It is also essential to ensure the documenting of data transformation process, which will allow the monitoring of the progress and the evaluation of the data processing.

97. Paragraph 156n): It is recommended as good practice to use metadata in steering and monitoring the processing of data from administrative registers, including their transformation. The use of metadata and principles should be used in the programming of the implementation of processes, collecting information on the course of the processes, and the outcomes of their implementation. Ensuring the high quality of census data is the overriding objective of these operations.
