



**UNIVERSITY** *of the*  
**WESTERN CAPE**

**Faculty of Natural Sciences**

**Department of Statistics and Population Studies**

## **How a population and housing census can be conducted after an epidemic, pandemic or a national crisis?**

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A Full thesis submitted in partial fulfilment of the requirements for the Degree of MPhil. in Population Studies, Department of Statistics and Population Studies, Faculty of Natural Sciences, University of the Western Cape, South Africa.

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i

## KEYWORDS

Africa

Computer-Assisted Personal Interviews (CAPI)

Computer-Assisted Telephonic interviewing (CATI)

Computer-Assisted Web Interviewing (CAWI)

Count

Data collection

Demography

French rolling census

Geographic Information System (GIS)

Housing census

Methodology

Population census



# ABSTRACT

## HOW A POPULATION AND HOUSING CENSUS CAN BE CONDUCTED AFTER AN EPIDEMIC, PANDEMIC OR A NATIONAL CRISIS?

MPhil full thesis, Department of Statistics and Population Studies, University of the Western Cape.

The population and housing census is the entire official process of enumeration of a country's residents and houses at a specified time. This process includes planning, demographic data collection, compilation, evaluation, analysis and dissemination. The census process is crucial for planning and policymaking to advance the country. In December 2019, there was the discovery of a deadly disease, COVID-19, which later spread globally and emerged to be a pandemic. The pandemic had detrimental effects on various aspects of life and especially on the census process in over seventy countries.

This research focuses on how a census can be conducted during and after an epidemic, pandemic and national or health crisis to avoid disrupting the census process in the future. A document review was conducted in five databases, including Scopus, PubMed, Web of Science, Ebscohost and Embase. Other hand searches were also made through normal searches on google scholar, research gate and other websites. The search was made to assess studies that documented how a census has been conducted before and during an epidemic, pandemic or national or health crisis or studies that suggest how a census can be conducted at any time. About 17126 articles were found after the search and duplicate removal, after the abstract screening, and full-text assessment only eighteen studies were eligible to be included in the study as the studies discussed how a census can be conducted during or after an epidemic, pandemic or crisis.

The results stated that other census methods were not explored thoroughly in most countries. The other census methods that can be explored as a quick replacement for the traditional census are telephonic interviews, web questionnaires, usage of mail and fax for census purposes. After which the collated information will be transferred to the respective statistics office. Subsequently, the countries can have a long-term goal of keeping an accurate population register and incorporating the French rolling census methods. As these are advanced methods that will aid the updating of the subsequent population data.

Currently, countries such as France, Canada, Australia and Saudi Arabia have conducted their census with these methods (CATI, CAWI and French rolling census) and these methods have

been proven to be effective. Therefore, other countries whose censuses were aborted by the COVID-19 pandemic are advised to adopt the CAWI, CATI, mail and fax methods and have a future plan for the French rolling census and keeping an updated population register. This will prevent aid the countries to have updated statistics for their houses and population and also prevent the future disruption of their census processes. GIS can also be used in place of the house-to-house counting for the housing census.



## DECLARATION

I, Tomiwa Temitayo Fapohunda, hereby affirm that '*How a population and housing census can be conducted after an epidemic, pandemic or a national crisis?*' is my work, that has not been submitted for any degree or examination in any academic institution, and that all the sources I have used or quoted have been indicated and acknowledged by complete reference.

Signature:.....

April 2022.



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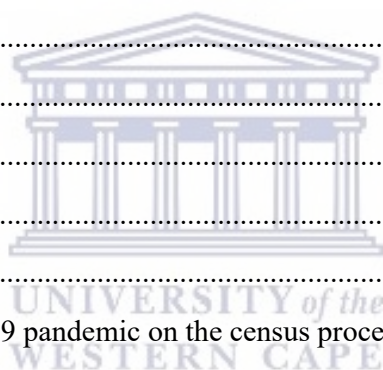


# TABLE OF CONTENTS

## Contents

KEYWORDS .....	ii
ABSTRACT .....	iii
DECLARATION .....	v
ACKNOWLEDGEMENTS .....	vi
LIST OF TABLES .....	xi
LIST OF FIGURES.....	xii
LIST OF ACRONYMS.....	xiii
CHAPTER 1: INTRODUCTION AND METHODOLOGY .....	1
1.1 Introduction.....	1
1.2 Problem statement.....	2
1.3 Research question .....	2
1.4 Significance of the study.....	2
1.5 Study aim .....	2
1.6 Study scope .....	2
1.7 Research design and methodology.....	3
1.8 Study design.....	3
1.9 Eligibility criteria .....	3
1.10 Keywords for search .....	3
1.11 Abstract screening.....	4
1.12 Full-text assessment .....	4
1.13 Data extraction .....	5
1.14 Data synthesis .....	5
1.15 Concluding summary .....	6
CHAPTER 2: LITERATURE REVIEW .....	7
2.1 Definition of terms.....	7
a. Census .....	7
b. Population census.....	7
c. Housing census .....	8

d.	Enumeration .....	9
e.	Administrative Register .....	9
f.	Computer-Assisted Telephone Interviewing (CATI) .....	9
g.	Computer-Assisted Personal Interviewing (CAPI).....	10
h.	Computer-Assisted Web Interviewing (CAWI) .....	10
i.	Document review .....	11
j.	Epidemic and pandemics .....	11
2.2	History of ancient census taking .....	11
2.3	History of modern census taking .....	13
2.4	Examples of epidemics .....	14
a.	The Black Death.....	14
b.	Cocolizti epidemic.....	15
c.	The influenza epidemic .....	15
2.5	Examples of pandemics .....	15
a.	Cholera .....	15
b.	Ebola.....	16
c.	The Spanish flu.....	16
d.	Coronaviruses.....	17
2.6	The impact of the COVID-19 pandemic on the census processes .....	36
2.7	Impact of the census postponement on the economy, data and NSO organisation .....	37
2.8	Other impacts of the COVID-19 pandemic .....	38
2.9	Significance of a census .....	39
a.	Population growth .....	40
b.	Population structure.....	40
c.	Modernisation of education and training.....	40
d.	Transformation .....	41
e.	Job creation .....	41
2.10	Significance of census to the sustainable development goals (SDG). .....	41
a.	Decent work and economic growth.....	43
b.	Gender equality .....	43





c.	National data system .....	43
d.	Improving individual freedom and rights.....	44
e.	Poverty alleviation.....	44
2.11	Census process (How to conduct a census) .....	44
a.	CATI method.....	44
b.	CAWI method .....	45
c.	Register-based census system using statistical register.....	45
d.	The traditional process of the census .....	46
e.	Census operations.....	50
f.	Census methods .....	50
g.	Demerits of the census process .....	50
2.12	Census political interactions and dependence .....	51
a.	Staffing issues .....	51
b.	Suppression or expansion of statistical field data collection.....	51
c.	Falsification of census data .....	51
d.	Politically motivated data suppression.....	52
e.	Delay in the census results dissemination.....	52
2.13	Concluding summary .....	53
CHAPTER 3: ANALYSIS AND RESULTS.....		54
3.1	Analysis.....	54
a.	Duplicates removal.....	54
b.	Abstract screening .....	54
c.	Full-text assessment .....	54
d.	Data extraction .....	54
e.	Included and excluded studies (Study results) .....	55
3.2	Discussion.....	55
CHAPTER 4: RECOMMENDATIONS AND CONCLUSION .....		60
4.1	Study relevance.....	60
4.2	Study limitations .....	60
4.3	Study findings .....	60

4.4 Conclusion ..... 61

    a. French rolling census as a means to palliate issues with the traditional census. .... 61

    b. Population register/ civil registration as a means to palliate issues with the traditional census. .... 62

    c. GIS as a means to palliate issues with the housing census ..... 64

4.5 Recommendations ..... 65

References ..... 68



## LIST OF TABLES

Table 1.1: Showing the keyword for the search.....	4
Table 2: How countries' census processes were impacted by COVID-19 (United Nations, 2020). ....	17
Table 3: Impact of the COVID-19 pandemic on different countries' census process, UNSD.....	23



## LIST OF FIGURES

Figure 1: Diagram showing the summary of the overall process.....	5
Figure 2: Diagram showing the population census in progress (Odimayo, 2018). .....	8
Figure 3: Diagram showing the population census (Odimayo, 2018).....	8
Figure 4: Diagram showing the housing census in process (MyGhanaDaily, 2021). .....	8
Figure 5: Diagram of a Computer-Assisted Telephone Interview in progress (Nicolaides, 2017). .....	9
Figure 6: Diagram of a Computer-Assisted Personal Interview in progress (Elliott, 2021). .....	10
Figure 7: Diagram of a Computer-Assisted Web Interview in progress (Research America, 2022). .....	10
Figure 8: Showing the countries whose censuses were affected by the COVID-19 pandemic. ....	23
Figure 9: Showing countries whose census fieldwork were postponed or stopped due to the COVID-19 pandemic by their geographical region .....	35
Figure 10: Showing countries whose census data collection process changed due to the COVID-19 pandemic by geographical region .....	36



## LIST OF ACRONYMS

AIDS: Acquired Immunodeficiency Syndrome  
CAPI: Computer Assisted Personal Interviewing  
CATI: Computer Assisted Telephone Interviewing  
CAWI: Computer Assisted Web Interviewing  
CDC: Centre for Disease Control  
CDD: Community-based door to door  
COVID-19: Coronavirus 2019  
CSV: Comma Separated Value  
GIS: Geographic Information System  
HIV: Human Immunodeficiency Virus  
LMIC: Low- and- Middle-Income Countries  
MERS: Middle East Respiratory Syndrome  
NA: Not Applicable  
NHIS: National Health Interview Survey  
NSO: National Statistics Office  
SARS: Severe Acute Respiratory Syndrome  
SDG: Sustainable Development Goals  
STI: Sexually Transmitted Infection  
UAE: United Arab Emirates  
UK: United Kingdom  
USA: United States of America  
UN: United Nations  
UNFPA: United Nations Population Fund  
UNSD: United Nations Statistics Divisions  
WHO: World Health Organisation



# CHAPTER 1: INTRODUCTION AND METHODOLOGY

Chapter 1 gives an overview of the introduction, research question, methodology, aim, scope, and significance of the study.

## 1.1 Introduction

A traditional census is a rigorous process which produces detailed statistics of a country's population and housing or a delimited part of the country's population or housing within a specific period (Department of Economic and Social Affairs Statistics Division, 2017). It involves mapping the entire country, training and mobilisation of enumerators, public campaigns, collection of individual and household information, questionnaire compilation and data analysis and dissemination (United Nations, 2008). The census is usually useful for policymaking and planning to advance the country. Although there are other types of census such as agricultural, business census etc., this study's emphasis is on population and housing censuses.

The census process is usually expensive; hence, it only occurs intermittently in different countries every five or ten years (Department of Economic and Social Affairs Statistics Division, 2017). In non-census years, some countries use vital statistics to keep updated population estimates (United Nations, 2008). In December 2019, there was the inception of the coronavirus (COVID-19) disease in Wuhan, China. The disease later spread and became a global disease, and it was declared a pandemic by the World Health Organisation (WHO) in March 2020. COVID-19 is an airborne, infectious, and very deadly disease with a high infection, hospitalisation and mortality rate.

Due to the nature of the disease, many countries declared a countrywide lockdown as the number of cases (infected people), and mortality (death) rate surged. In more than seventy countries such as Algeria, Costa Rica, and Portugal, housing and population censuses were rescheduled from 2020 to 2021 and indefinitely, depending on the pandemic's infection, mortality and hospitalisation rates. This delay was reasonable as an attempt to continue the traditional census process as planned for 2020 before the disease would have been detrimental to public health (causing an increase in infection rate), and there was also a high risk of collection of inaccurate data (Whitby, 2020).

The pandemic triggered economic issues such as massive retrenchment, revenue loss, the shutdown of businesses, malnutrition, hunger and extreme poverty. Also, the demographic consequences of the pandemic are adverse effects such as delay in the census process in over seventy countries, increased inequality and mortality rate. In light of these issues (census delay

due to the COVID-19 pandemic), this research is set to investigate how censuses can be conducted accurately during health and national crisis. The study used the document review method to collate information on how a census can be conducted after an epidemic, pandemic or national crisis, as this can be used for future purposes.

## **1.2 Problem statement**

Although various vaccines for COVID-19 have been approved and administered in several countries such as South Africa, the United Kingdom (UK), and France, however, the rollout is still slow, and several people are still yet to receive their vaccine. The prevalence of COVID-19 is still high in different countries, and most countries are not yet certain when their census will be conducted. Censuses were cancelled in more than seventy countries in 2020 because of the COVID-19 pandemic (United Nations, 2020). This was to prevent the spread of the disease and inaccuracies and inconsistency in the data collection. This research would help policymakers and planners to plan censuses and get accurate data right after a health or national crisis.

## **1.3 Research question**

- ❖ How was a census conducted previously after a national or health crisis?
- ❖ How can a census be successfully conducted after an epidemic, pandemic, or national lockdown like COVID-19 or other national crises?

## **1.4 Significance of the study**

This research explores a better way to conduct a census without the process of the house to house counting (the traditional census method will be suggested for planning and decision making). This will also help policy and decision-makers to plan censuses efficiently right after a national or health crisis.

## **1.5 Study aim**

This study aims to investigate how the census was conducted previously after a global, national or health crisis and to suggest a way for policymakers how a census can be conducted after a pandemic, epidemic, or national lockdowns like COVID-19 or other national crises.

## **1.6 Study scope**

This study gathered and analysed resources on censuses (document review). Lessons from the past on how censuses were conducted during pandemics, epidemics and national crises were

studied to be able to proffer a solution to how censuses can be conducted after a health or national crisis.

## **1.7 Research design and methodology**

This part discusses the research design and methodology of this study. Starting from the study design, research questions, inclusion criteria, quality assessment, keywords for search, data source, quality assessment, and presentation of results.

## **1.8 Study design**

This study is a document review with a secondary source of information which is a qualitative study design. The researcher studied and interpreted documents on a given topic to explain the topic and give a contextual overview of the topic.

## **1.9 Eligibility criteria**

All studies that describe how the census was conducted right after an epidemic, pandemic or national crisis were included in the study. Studies with any form of method will be included in this document review (methods like qualitative, quantitative, mixed, document review, systematic and scoping review). Studies discussing census methods that can be used during an epidemic, pandemic or national crisis will be excluded.

## **1.10 Keywords for search**

An information professional (librarian) was consulted to assist with the search to guarantee the accuracy of the search strategy. The combination of search tools and skills, subject heading, Boolean operators, proximity search, keyword search and hand search was used for the document review search strategy to confirm the accuracy of the search. The database that were searched were Scopus, Ebscohost, web of science, PubMed, and Embase, and they were searched with the use of Boolean operators (such as or & and). The keywords that were used in the search are stated in the table below (Table 1).



**Table 1: Showing the keyword for the search**

<b>Keywords</b>	<b>Synonyms</b>	<b>Broad</b>	<b>Narrow</b>
Census	General census, population census, enumeration, counting, count, national count, numeration, population count, listing, tally, evaluation, register and information gathering.		
Pandemic	Epidemic	National health crisis, public health crisis, global crisis, 'pandemic in history', 'epidemics in history'.	COVID-19, Ebola, MARS, influenza, COV2, MARS, SARS
National	Country	International, continental, region.	Province, state.
Conduct	Methodology, Impact		Delay, postponement, cancellation.

### **1.11 Abstract screening**

The selected study was exported to Endnote for duplicate removal and then exported to Rayyan for abstract and title screening. Abstract and title screening involves reading the title and abstract of the paper to assess if its content correlates with the study's research question. Rayyan was used to collate the document, the title and abstract screening and decide whether to include and exclude the paper in this review. The research questions guided the reviewer's decision to include or exclude the study.

### **1.12 Full-text assessment**

After the abstract screening, the papers that meet the criteria were downloaded and read thoroughly to assess eligibility for inclusion in the study. Rayyan was used to make the reselection after the full-text reading. Authors of significant papers that cannot be assessed online were contacted to get the full text of the paper for the study. The studies that answer the research questions were extracted in excel sheets.

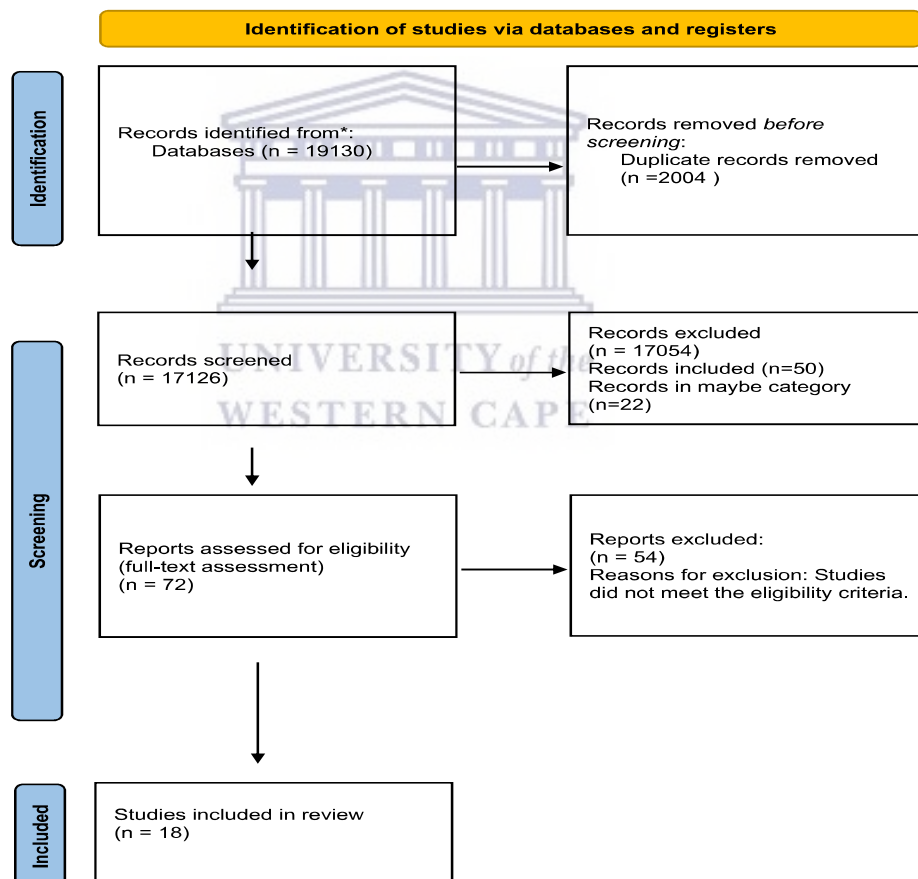
### 1.13 Data extraction

Relevant papers (papers containing information related to the research questions) were extracted from the data sources with the search strategies described above. The information collected from the relevant papers is the authors, year of publication, method, data collection method, country of origin and reviewer’s comments.

### 1.14 Data synthesis

After the data extraction, the narrative synthesis of the extracted review was conducted. The study findings were explained narratively. The relationships between and within the studies were being explored. For the studies that would be included, a preliminary synthesis of the studies was conducted, and the robustness of the synthesis was assessed.

Figure 1: Diagram showing the summary of the overall process



## 1.15 Concluding summary

Chapter 1 described the introduction, problem statement, research question, significance, aim, and scope of the study. This chapter also describes the study's research design and methodologies, including inclusion criteria, keywords for search, abstract screening, full-text assessment, study design, data extraction, and synthesis. The next chapter gives an elaborate overview of the study's literature review.



## CHAPTER 2: LITERATURE REVIEW

The preceding chapter discusses the background and introduction of this study. This chapter elucidates more of the study by elaborating on the significance of the census, the definition of related terms and other related literature reviews on censuses.

### 2.1 Definition of terms

Terms like census, enumeration, administrative register, Computer-Assisted Telephone Interviewing (CATI), Computer Assisted Personal Interviewing (CAPI), Computer-Assisted Web Interviewing (CAWI), document review, epidemic and pandemic are defined to give a proper perspective and understanding of these terms.

#### a. Census

A census is the enumeration of people, items, houses, firms and other things of a particular population, country or region at a given time (Ministry of Development Planning and Statistics, 2020). A census counts the ages, birth origin, race, immigration or citizenship status of everyone living in a certain country (States and Islands, 2016). Many countries also conduct manufacturing, housing and agriculture censuses. Kenya conducted the first animal census ever in 2021 (Halima, 2021). A census is conducted in five to ten years because they are usually expensive (Measure Evaluation, 2017). However, the interval depends on the country (Measure Evaluation, 2017). Vital statistics are used to project the number of birth, death and migration in non-census years (Department of Economic and Social Affairs - Statistics Division, 2014).

#### b. Population census

The United Nations defines population census as the overall process of compiling, planning, evaluating, collecting, analysing and disseminating social and economic data at the smallest geographic level pertaining, at a specific time in a well-delimited part of a country or to all persons in a country (Department of Economic and Social Affairs Statistics Division, 2017). Population census is crucial for social development and economic planning, scientific research, administrative activity or balance. Additionally, it provides detailed and reliable data on the population size, composition and distribution (Department of Economic and Social Affairs Statistics Division, 2017).

**Figure 2: Diagram showing the population census in progress (Odimayo, 2018).**



**Figure 3: Diagram showing the population census (Odimayo, 2018).**



**c. Housing census**

The United Nations defines a housing census as the overall process of compiling, collecting and disseminating information on buildings (living and non-living quarters) and building facilities such as sewage systems, electricity, and bathrooms. This process focuses on the statistical data that is related to the condition and number of housing facilities and units of available households, at a specific time, all living quarters and occupants in a well-delimited part of a country or a country as a whole (Department of Economic and Social Affairs Statistics Division, 2017).

**Figure 4: Diagram showing the housing census in process (MyGhanaDaily, 2021).**



**d. Enumeration**

This is the process of the detailed numbering of items and persons in a household for a census (Clague, 2001). It is known as counting, numeration and taking inventory. The success of a census largely depends on the enumeration process (Stats SA, 1998). This process must be quick, efficient and done with proven methods (Clague, 2001). It depends on different factors such as budgetary constraints of the country, census laws, and other concurrent national situations (Stats SA, 1998). Methods used can include face-to-face interviews, questionnaires, electronic responses, mail out and mail-back of the questionnaire. Furthermore, the right timing of the enumeration process aids the completeness of the census (Clague, 2001).

**e. Administrative Register**

This is the use of a register to gather social and demographic statistics for a country’s administrative purposes (International Labour Organization, 2017). They are sources of statistical registers, and they gather information on buildings, persons and businesses of a target population (UNECE, 2019). Updating the administrative registers helps keep track of changes in the target population over time (International Labour Organization, 2017).

**f. Computer-Assisted Telephone Interviewing (CATI)**

This is a type of survey that involves the use of a telephone for interviews following a pre-planned (structured) questionnaire to gather information (David Chapman, 1990). CATI speeds up the data collection process and enhances the collection of accurate and timely data from the respondents (Elliott, 2020). The conversations are usually recorded and listened to or transcribed afterwards to ensure that all the key information is captured (David Chapman, 1990). They are cheaper, more efficient, less time-consuming, and more intensive than the traditional census (GAO Library system, 1979).

**Figure 5: Diagram of a Computer-Assisted Telephone Interview in progress (Nicolaidis, 2017).**



**g. Computer-Assisted Personal Interviewing (CAPI)**

This is a data collection method that involves the use of face-to-face interviews using tablets, computers and mobile phones to record the answers of the interview (Stats SA, 2018). CAPI usually relies on electricity, Wi-Fi and data connection (Elliott, 2012). After the interviews, the census answers are immediately uploaded in an electronic format to a central database. This makes the data analysis easier and faster than the traditional census process (Census Bureau, 2016). However, one of the disadvantages is that it might be difficult to conduct in places with high crime rates (Census Bureau, 2016).

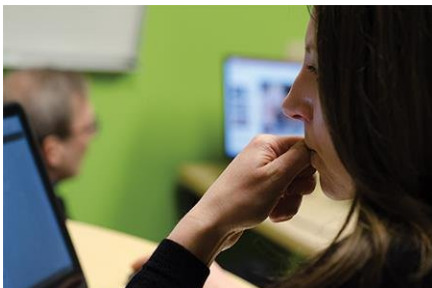
**Figure 6: Diagram of a Computer-Assisted Personal Interview in progress (Elliott, 2021).**



**h. Computer-Assisted Web Interviewing (CAWI)**

This type of survey involves using website interviews using a structured web-based questionnaire to gather information (Elliott, 2012). They are cheaper and not time-consuming compared to the traditional census process. The response can be collected, analyzed and collated quickly since the data are collected on a central database (Stats SA, 2018). Errors can also be easily corrected on the online questionnaire (Census Bureau, 2016). However, one of the disadvantages of CAWI is that some of the target population may not have access to an internet connection (Census Bureau, 2016).

**Figure 7: Diagram of a Computer-Assisted Web Interview in progress (Research America, 2022).**





### **i. Document review**

Document review is a process of gathering all empirical evidence that is sufficient to answer a research question (Bowen, 2009). A document review comprises all published articles, books, deliberations and information on a particular topic (Bowen, 2009). This review also helps policymakers make decisions (CDC report, 2018).

### **j. Epidemic and pandemics**

An epidemic is a fast spread of disease within a short time to a large number of people in a certain population (Anomaly, 2018). A pandemic is an epidemic with global coverage, with wider geographical area coverage, usually worldwide (Morens, Folkers and Fauci, 2009). The world has experienced several epidemics and pandemics that have killed several people. The epidemics and pandemics will be further explained below. The next section gives an overview of the ancient history of census taking.

## **2.2 History of ancient census taking**

The previous section explained some crucial terms in this study, and this section gives a literature review overview of the history of the ancient methods of census taking. The Roman Empire started its census in the sixth century BC, its citizens were usually instructed to go back to their place of birth every five years for the census process and the census information was used to register their citizens and properties and to regulate taxes, privileges or duties (Statistics, 2016b). Census taking started in Israel right from the ancient days of the Bible. The census was for tax purposes, and the book of Numbers was named after their census-taking process (Wright, 2002). The oldest census in India was recorded under the leadership of Ashoka and Chanakya under the reign of Emperor Chandragupta Maurya in 330 BC (India, 2011).

Egyptians used the census to structure their labour force and share their land as of 2500BC (Statistics, 2016a). The Babylonian empire took the first known census in 3800 BC (PRB, 2020). The process involved counting milk, vegetables, honey, wool, butter and livestock (PRB, 2020). During ancient times it was found that census notes were recorded on clay tiles; some of these clay tiles can still be found in the British Museum (Statistics, 2016a). A census was used as a guide to know how much food the Egyptians, Roman, Chinese and Greek civilizations needed to provide for their residents, around 4000BC (Statistics, 2016a).

China held one of the world's oldest and most accurate preserved censuses during the reign of the Han Dynasty in AD2 (Hays, 2010). The census registered 12,366,470 households and 57,671,400 persons, and the largest city, Chengdu, was with 282,000 persons. However, only



taxable families were considered (Hays, 2010). In 1086, the Domesday Book counted the English landowners and their possessions. This was to form their tax system basis, and it was conducted by William the conqueror. From 1250 to 1270, the Mongols conducted a census of Russian, Asian and Chinese people that they captured. This was to demand resources in place of a peace treaty from captured persons (PRB, 2020).

In 1400, the Incas used a system of knots and strings that were made from alpaca hair or llama to record the census data as there was no written language then (PRB, 2020). This information was used to administer and control their empire. There is an indication from historical documents that population registration had been adopted before 1573 (Ahmed, 2000). Though the exact year was not recorded, the effort was usually made in the seventeenth century to ensure the count of everyone in the country within a three-day counting period (Ramazan) in the Maldives (Ahmed, 2000). The count was used to identify persons to pay charity contributions and religious obligations.

The first total world estimate was prepared in 1661 by Giovanni Battista Riccioli. There was census opposition between the 1700s and 1800s (PRB, 2020) by European colonialist nations such as Denmark, France, and England opposed any census process due to nobility opposition as they feared losing power to their central government (PRB, 2020). Meanwhile, during this time, the Americans, Iceland and the Caribbean promoted the census process for growth promotion and maintaining a well-taxed society (Gauthier, 2002). The second world estimate in 1741 by Johann Peter Süssmilch (though it was revised in 1762). In 1790, the first US census was conducted by enumerators on horseback, which took eighteen months to conduct (Margo J, Jensen and Anderson., 1989).

The census opposition stopped after Thomas Malthus published an article in 1798 on the principles of population (Statistics, 2016a). The article explained the importance of the census to population growth (Statistics, 2016b). Later in the 18<sup>th</sup> and 19<sup>th</sup> centuries, an annual enumeration was usually conducted for the adult population (between the ages of fifteen and sixty) to identify the taxpayers (Ahmed, 2000). In 1853, Chile established the South Americans' first census law (PRB, 2020). The third world estimate in 1859 by Karl Friedrich Wilhelm Dieterici (Fay, 1967).

The Native Americans and enslaved people were not counted until 1860 and after the Civil War in 1861-1865, respectively (Margo J, Jensen and Anderson., 1989). The census results determined the House of Representatives' size (PRB, 2020). In 1871, the local British population were reluctant to take in the census process due to false rumours that the census aimed to pick out girls to fan Queen Victoria of England during the heatwave (Duke-williams,

2012). In 1890, the first-ever electronic tabulating machines were used for the census in the USA and this advanced the technical development of their census process (PRB, 2020).

### **2.3 History of modern census taking**

The previous section gave an overview of the census in ancient times, and this section will discuss the history of modern census-taking between the twentieth and twenty-first centuries. In 1911, technology made the census process easier (Statistics, 2016b) as they introduced punch cards, mechanical counting and sorting for census taking. In the Maldives, the population census was conducted for the first time in 1911; although there were records of counting in the eighteenth and nineteenth centuries, the population census was subsequently conducted every ten years (Decennial); in 1921 and 1931 (Ahmed, 2000). In 1930, the census in the USA indicated that the population was growing rapidly due to the immigrant influx (Gauthier, 2002). This guided the quota allocation for the northern European (desirable) and southern European (undesirable) immigrants in 1932 using the 1930 census results (Gauthier, 2002).

According to Walter Willcox, the estimated world population to about 1.8 billion in 1931 (Fay, 1967). In ancient Greece, several census records were conducted (Missiakoulis, 2010). The census was first recorded in Egypt late in the middle Kingdom, and they were advanced in the new kingdom. The Egyptian government officials also conducted many censuses under the Romans and Ptolemies (Gruen, 2016). The census process was interrupted during World War 2 and resumed in 1946 (Ahmed, 2000). In 1958, the United Nations Statistical Commission established the first set of recommendations and principles guiding housing and population censuses (PRB, 2020). This responded to the need for housing and population censuses international standards (PRB, 2020).

The use of computers for the census process was first introduced in 1961 (Statistics, 2016b). More census was recorded till 1974 as conducted by the Ministry of Home affairs. Information about age, sex, education, marital status, activity and occupation were recorded. The modern census in the Maldives was in 1977 with technical aid from the United Nations Population Fund (UNFPA) (Ahmed, 2000). In 1983, the West government in Germany tried to link records of censuses to results of population registers due to a census cancellation plan (Pfister and Fertig, 2010). However, a modified census was eventually conducted four years after (1987). The unified first census count in Germany was 80.2 million persons in 1990 (Pfister and Fertig, 2010).

Countries such as Afghanistan, Eritrea, Lebanon, Somalia, Western Sahara and Uzbekistan have not conducted a census since 1990 (PRB, 2020). In 2001, above 390,000 respondents in England and Wales identified as having a Jedi belief system after the internet campaign that their belief system would receive official recognition from the government if supported by numerous persons (PRB, 2020). In 2010, it was recorded that China has the largest population in the world, 1.3 billion persons, with a need to employ ten million census workers for the census process (PRB, 2020).

In 2011, Britain marked the 210 years of modern census taking, and the twenty-first census took place as they occurred at ten-year intervals (Statistics, 2016b). In 2012, Brazil assisted the Senegal census by providing information gathering and other processing technologies (CGTN, 2021). These resources provided greater reliability and faster collation and result dissemination (CGTN, 2021). In 2019, the Democratic Republic of Congo began the second census preparations in history after its first census in 1984, although its second census was affected by Ebola and COVID-19 pandemic (Kullenberg, 2020).

## **2.4 Examples of epidemics**

The previous section gives a literature review of the modern history of census taking. This segment states examples of epidemics that have occurred in the past, their symptoms, affected countries, and treatments. There have been several occurrences of an epidemic in the past years since the inception of the census process. Some of these events are briefly explained below to have some examples of the overview of epidemic time assessed in this study. Some epidemic examples that were explained are the black death, cocoltizi and influenza.

### **a. The Black Death**

This disease started in 1332 in China, and it spread to Europe and across the trade route (Britannica, 2020). About 60% of people in European countries were wiped out due to the epidemic (ThoughtCo, 2020). It was also called Black or septicemic Plague. The signs and symptoms were abdominal pain, shock, chills, weakness, fever, tissue bleeding, death and black colouration of the dead tissues. Symptoms and signs may be between two to seven days after contracting the infection. It was treated with antibiotics, and the treatment was most effective in early administration. However, vaccines were not available. The diagnosis depended on identifying causative bacteria in the tissue samples of bacteria. The causative bacteria is *Yersinia pestis*.

### **b. Cocolizti epidemic**

It was also called the great pestilence as it resulted in the death of millions in the 16th century (around 1567) in Mexico. The disease had a devastating effect, especially on the native Aztec area's demography. The Cocolizti epidemic is known as the worst epidemic in Mexico's history due to the death toll. The symptoms were severe headache, neck and head nodules, high fever, dark urine, black tongue, dysentery, jaundice, bleeding from the eyes, mouth and nose, neurologic disorders, chest and abdomen pain and death between three to four days. There were also some other symptoms, such as haemorrhage in the gastrointestinal tracts, which led to bloody diarrhoea, spotted skin and vagina bleeding. The symptoms of this disease are very similar to Ebola, but it also includes Jaundice, neck nodules and dark tongue (Fields, 2008).

### **c. The influenza epidemic**

This epidemic started in 1918 (Beth, 2013). It is said to have been the most dangerous epidemic in history, which killed more persons than in World War One (Roos, 2020). It was estimated that twenty to forty million people were killed in this epidemic (Britannica, 2021). The symptoms are chills, fever, headache, aching muscles, shortness of breath, sore throat, eye pain, weakness, stuffy or running nose, cough, sweating, diarrhoea and vomiting (Molly Billings, 1997). There are further explanations and examples of pandemics below.

## **2.5 Examples of pandemics**

There are some examples of epidemics that have occurred in the past above, and this section will give some pandemic examples. There have been several occurrences of an epidemic in the past years since the inception of the census process. Some of these events are briefly explained below to have some examples of the overview of the pandemic time assessed in this study. The pandemic examples that were explained are Cholera, Spanish flu and the Coronaviruses.

### **a. Cholera**

Cholera has been occurring from 1817 to date (Mariam, 2021). The first cholera pandemic occurred from 1817 to 1824 through rice contamination in India, and it spread throughout Asia and the Middle East through trade routes (History, 2018). The symptoms include leg cramps, vomiting and diarrhoea and lead to death if not well treated within twelve hours to five days (Mayo Clinic, 2020)(World Health Organization, 2021). The second wave occurred from 1829 to 1851; it covered the Americans and Europe (Marc, 2018). The deadliest and third wave of the pandemic occurred from 1852 to 1859. Cholera is still endemic in some countries like Africa, Asia, America, the Middle East and Latin now (Bree, 2021). John Snow (a British

epidemiologist) discovered the cause of the pandemic, and the rate reduced drastically (Marc, 2018).

#### **b. Ebola**

Ebola virus disease is also known as Ebola haemorrhagic fever. This epidemic occurred in phases in different countries. The first was in 1976 in South Sudan and the Democratic Republic of Congo; the second phase was from 2014 to 2016 in West Africa; the third phase was from 2018 to 2020 in the Democratic Republic of Congo (Nazimek *et al.*, 2014). The second phase was the deadliest. The number of cases that were recorded was 28,000. The disease symptoms are headache, fever, muscle pain, intense weakness, diarrhoea, vomiting and sore throat (Ambardekar, 2018). Some patients experience rash, hiccups, red eyes, impaired liver and kidney and external and internal bleeding (CDC, 2015). The Ebola virus is usually transferred through contact with infected body fluids (Jordan, Tumpey and Jester, 2019). It is a fatal disease in some primates such as humans, rhesus monkeys, baboons, and chimpanzees.

Ebola was transmitted from wild animals such as porcupines, fruit bats, etc. to humans, and the spread in humans is through direct contact with secretions, blood, organs or other fluids in the body and also contact with materials and surfaces such as clothing and bedding that are contaminated with the fluids or secretions (CDC, 2019). The best way to prevent the spread is to avoid contact with the body fluid of an infected person (Jordan, Tumpey and Jester, 2019). The average fatality rate of Ebola cases was 50%. Supportive care of treatment of symptoms and rehydration with intravenous or oral fluids helps improve survival (World Health Organization, 2020). The Ebola virus impacted West African countries such as Guinea, Sierra Leone and Liberia's healthcare services severely as there were setbacks in controlling and treating tuberculosis, malaria, HIV, and measles during this epidemic (World Health Organization, 2014).

#### **c. The Spanish flu**

The Spanish flu was the pandemic of the 20th century, which occurred from 1918 to 1919 (Britannica, 1919). The origin of the disease was not known, but the first known case was from the US (Jordan, Tumpey and Jester, 2019). The Spanish flu was very similar to COVID-19 because it spreads through respiratory droplets like the coronavirus (Claire, 2020). The symptoms of the disease were chills, fever, fatigue and pneumonia. The flu was very deadly, and it killed 50 – 100 million people and infected 500 million people (CDC, 2018).

#### d. Coronaviruses

Coronaviruses are a group of RNA-related viruses that cause disease in humans. However, they are usually transferred from animals (birds and mammals) to humans (Loraine, 2020). Some lethal examples of coronaviruses in history are Middle East Respiratory Syndrome (MERS), severe acute respiratory syndrome (SARS) and the novel COVID-19 (Martin, 2020). MERS-CoV and SARS-CoV are the closest to the novel COVID-19, and due to the similarity of these pandemics, we can use the comparison to best explain how to handle a pandemic (Martin, 2020). The symptoms of these viruses were cold, cough, fever, pneumonia and respiratory tract infections. The diagnosis can be with polymerase chain reaction (PCR). The COVID-19 mortality rate is lower than SARS and MERS, but COVID-19 has more reported cases (Martin, 2020).

SARS and MERS had different responses to COVID-19; they show us how dangerous a country's health sector's lack of preparation for pandemics and timely decisions can affect the economy and other country sectors (Loraine, 2020). These pandemics and epidemics occurred in ancient times, which might have disrupted census processes in those years. The major impact of the COVID-19 pandemic on the census process in different countries globally is the postponement of the census process (United Nations, 2020). Some countries have postponed their census process to 2021 and some to 2022 (United Nations, 2020).

Several countries also declared a lockdown as the number of cases (infected people) increased (Han *et al.*, 2020). More than seventy national censuses that were supposed to be conducted in 2020 were rescheduled for 2021 (Han *et al.*, 2020). The census was delayed and rescheduled due to the present pandemic (COVID-19) and the global lockdown. This delay is reasonable as attempting to continue with the census in 2020 as planned before the disease outbreak can affect public health (by increasing the number of cases) and data quality (accurate data might not be collected) (Whitby, 2020). The pandemic had different impacts in several countries. Table 2 gives a summary of how the census was affected.

**Table 1: How countries' census processes were impacted by COVID-19 (United Nations, 2020).**

S/N	Countries	Proposed dates of the census before the COVID-19 pandemic	Census process affected by COVID-19 pandemic	If the pandemic has not affected the census process adversely, state why.
1	Albania	NA	Yes	Not Applicable (NA)
2	Algeria	15/11/2020	Yes	NA



3	American Samoa	1/4/2020	Yes	NA
4	Anguilla	1/8/2020	Yes	NA
5	Antigua and Barbuda	25/5/2021	Yes	NA
6	Argentina	28/10/2020	Yes	NA
7	Armenia	18/10/2020	Yes	NA
8	Aruba	1/10/2020	Yes	NA
9	Austria	31/10/2021	No	Administrative registers are being used as a source of census data.
10	Bahamas		Yes	NA
11	Bahrain	17/3/2020	No	Administrative registers are being used as a source of census data.
12	Bangladesh	2/1/2021	Yes	NA
13	Barbados	1/5/2020	Yes	NA
14	Belgium	1/1/2021	Yes	NA
15	Belize	12/5/2020	No	Administrative registers are being used as a source of census data.
16	Botswana	10/08/2021	Yes	NA
17	Brazil	31/07/2020	Yes	NA
18	The British Virgin Islands	15/06/2020	Yes	NA
19	Bulgaria	22/01/2021	Yes	NA
20	Cameroon		No	NA
21	Cayman Islands	11/10/2020	Yes	NA
22	Chad	1/05/2019	Yes	NA
23	China	11/01/2020	Yes	NA
24	Costa Rica	09/06/2021	Yes	NA
25	Cote d' Ivoire	20/04/2020	Yes	NA
26	Croatia		Yes	NA
27	Curacao	18/04/2020	Yes	NA
28	Cyprus	1/10/2021	No	It cannot be said that the census will be adversely affected currently by the pandemic. This is dependent on the duration of the pandemic and if the census process will be postponed or affected

29	Czechia	26/01/2021	Yes	NA
30	Congo DRC		Yes	NA
31	Denmark	1/1/2021	No	Administrative registers are being used as a source of census data.
32	Djibouti	31/12/2020	Yes	NA
33	Dominica	15/05/2021	Yes	NA
34	Dominican Republic		Yes	NA
35	Ecuador	29/11/2020	Yes	NA
36	Estonia	31/12/2021	No	Census preparations are still being made, hence, the effect of the pandemic on the census cannot yet be stated.
37	Finland	1/1/2021	No	Administrative registers are being used as a source of census data.
38	Germany	16/05/2021	Yes	NA
39	Greece	16/05/2021	Yes	NA
40	Greenland	1/1/2021	No	Administrative registers are being used as a source of census data.
41	Grenada	12/05/2021	Yes	NA
42	Guam	1/4/2020	Yes	NA
43	Hungary	1/5/2021	Yes	NA
44	Iceland	1/1/2021	Yes	NA
45	India	1/3/2021	Yes	NA
46	Indonesia	15/09/2020	Yes	NA
47	Israel	1/5/2021	Yes	NA
48	Italy	3/10/2021	Yes	NA
49	Jamaica	5/4/2021	Yes	NA
50	Japan	1/10/2020	Yes	NA
51	Kazakhstan	1/10/2020	Yes	NA
52	Kyrgyzstan	23/3/2020	Yes	NA
53	Latvia	1/1/2021	No	Administrative registers are being used as a source of census data.
54	Liberia	3/3/2021	Yes	NA
55	Liechtenstein	31/12/2020	Yes	NA
56	Lithuania	1/1/2021	No	Administrative registers are being used as a source of census data.
57	Luxembourg	1/1/2021	Yes	NA



58	Malaysia	7/7/2020	Yes	NA
59	Malta	10/10/2021	Yes	NA
60	Marshall Islands	7/7/2021	No	The country is COVID-free; hence, the census is not adversely affected by the pandemic.
61	Mauritius		Yes	NA
62	Mexico	5/31/2020	Yes	NA
63	Micronesia (the Federal States of)	5/4/2020	Yes	NA
64	Mongolia	9/1/2020	No	Census fieldwork was completed before the arrival of the COVID-19 pandemic.
65	Montenegro			There is no adoption of the census law in Montenegro.
66	Montserrat	12/5/2021	Yes	NA
67	Namibia	29/8/2021	Yes	NA
68	Nepal	22/6/2021	No	Preventive measures are being adopted during the census and the COVID-19 incidence rates are decreasing.
69	Netherlands	1/1/2021	No	Administrative registers are being used as a source of census data.
70	Nicaragua		No	Economic reasons
71	Niger	20/12/2021	Yes	NA
72	North Macedonia		No	Administrative registers are being used as a source of census data.
73	Northern Mariana Islands	1/4/2020	Yes	NA
74	Norway	1/1/2021	No	Administrative registers are being used as a source of census data.
75	Oman	12/12/2020	No	Administrative registers are being used as a source of census data.
76	Panama	24/5/2020	Yes	NA
77	Philippines	1/5/2020	Yes	NA
78	Poland	31/3/2021	Yes	NA
79	Portugal	24/3/2021	Yes	NA
80	Puerto Rico	1/4/2020	Yes	NA
81	Qatar	17/3/2020	Yes	NA

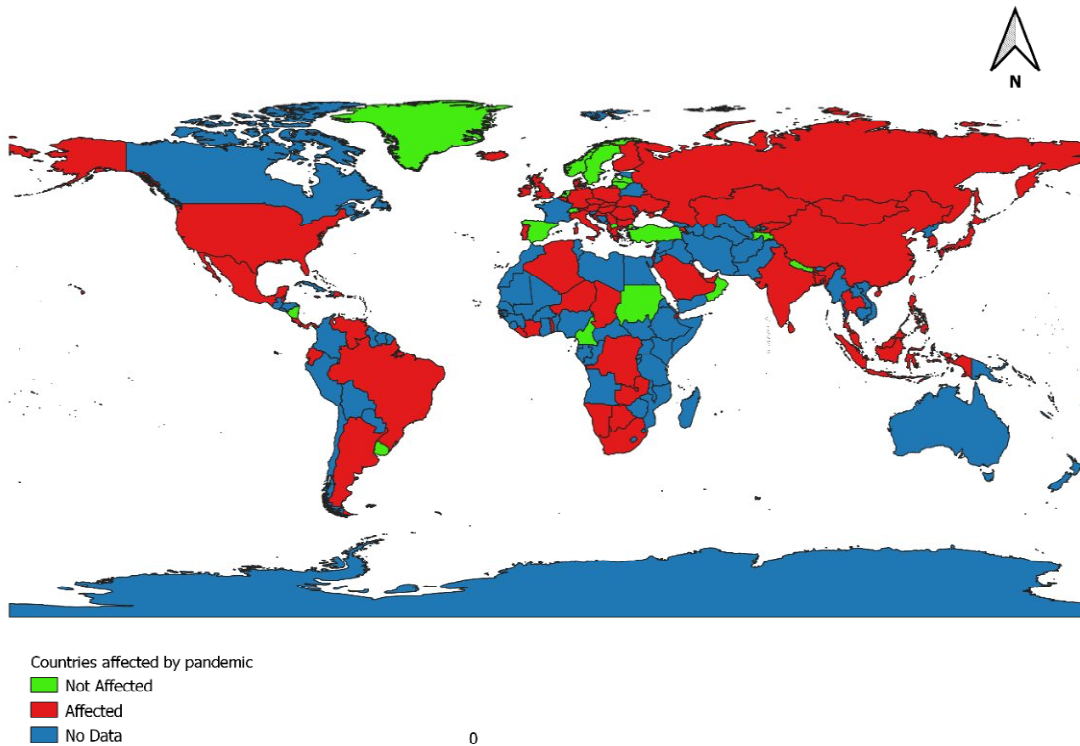
82	Republic of Korea	1/11/2020	Yes	NA
83	Romania		Yes	NA
84	Russian Federation	1/4/2021	Yes	NA
85	Saint Kitts and Nevis	16/9/2021	Yes	NA
86	Saint Lucia	12/5/2020	Yes	NA
87	Saint Vincent and the Grenadines	15/6/2021	Yes	NA
88	San Marino		No	Administrative registers are being used as a source of census data. Census is usually conducted at irregular intervals.
89	Saudi Arabia	17/3/2020	Yes	NA
90	Serbia	31/3/2021	Yes	NA
91	Seychelles		Yes	NA
92	Singapore	30/6/2020	Yes	NA
93	Slovakia		Yes	NA
94	South Africa	28/10/2021	Yes	NA
95	Spain	1/1/2021	No	Administrative registers are being used as a source of census data.
96	Sri Lanka	22/11/2021	Yes	NA
97	Sudan		No	The population census is scheduled for 2022.
98	Sweden	31/12/2021	No	Administrative registers are being used as a source of census data.
99	Switzerland	31//12/2021	No	The Swiss census is usually conducted yearly since 2010. The use of sample survey data (with online and paper forms) and registered data are adopted.
100	Tajikistan	1/10/2020	No	The census took place as scheduled. Preventive measures are being adopted during the census. Also, enumerators were provided with disposable gloves, disposable masks, antiseptics etc.
101	Thailand	1/7/2020	Yes	NA
102	Togo	9/11/2021	Yes	NA

103	Turkey	31/12/2021	No	Administrative registers are being used as a source of census data.
104	Ukraine	30/10/2020	Yes	NA
105	United Arab Emirates	13/12/2020	Yes	NA
106	The United Kingdom and Northern Ireland	21/3/2021	Yes	NA
107	United States of America	1/4/2020	Yes	NA
108	United States Virgin Islands	1/4/2020	Yes	NA
109	Uruguay		No	The population census is planned for 2023.
110	Venezuela	1/9/2020	Yes	NA
111	Zambia	18/8/2020	Yes	NA

**Note:** The table above (table 2) gave an overview of countries whose census processes were affected during the COVID-19 pandemic. Table 3 is stating the census process that were truncated due to the COVID-19 pandemic.

### **GIS ANALYSIS OF COUNTRIES CENSUS PROCESSES THAT WERE AFFECTED BY THE PANDEMIC**

To better present an illustrative view of the countries whose censuses were affected by the COVID-19 pandemic by geographical region, a GIS analysis was carried out using the data in Table 2 above. The table was saved as a Comma Separated Value (CSV) file and imported into the GIS environment. A shapefile of administrative boundaries of the world map was obtained and a join analysis was carried out in the GIS environment to join the data in Table 2 to the attribute table of the several countries' boundary shapefile. A map was therefore created using a graduated colour scheme based on if the countries' census processes were affected column as shown in Figure 8 below. More than seventy countries' censuses were affected by the pandemic as they rely on the use of the traditional house-to-house census method for their census process.



**Figure 8: Showing the countries whose censuses were affected by the COVID-19 pandemic.**

**Table 2: Impact of the COVID-19 pandemic on different countries' census process, UNSD**

2020 (United Nations, 2020)

S/N	Countries	Impact of COVID-19 on census fieldwork	Impact of COVID-19 on census data collection	Impact of COVID-19 on census preparation
1.	Albania	The fieldwork was postponed to 2022.	The data collection method did not change.	The procurement and training were postponed/cancelled due to the COVID-19 pandemic.
2.	Algeria	The fieldwork was postponed to 2021.	The data collection method did not change.	The census preparation/cancelled was not affected.
3.	American Samoa	The enumeration was extended by weeks/months in 2020.	The data collection method was adapted/changed to CATI.	The enumeration was postponed/cancelled due to the COVID-19 pandemic.
4.	Antigua and Barbuda	The fieldwork was postponed to 2022.	The data collection method was	The mapping/listing, pilot census, publicity, stakeholder outreach, procurement, training, and

			adapted/changed to CATI and CAWI.	recruitment of some key staff were postponed/cancelled due to the COVID-19 pandemic.
5.	Argentina	The fieldwork was postponed to 2021.	The data collection method was adapted/changed to CAWI.	The pilot census and training were postponed/cancelled due to the COVID-19 pandemic.
6.	Armenia	The fieldwork was postponed to 2021.		The mapping, listing, cartography, publicity and training were postponed/cancelled due to the COVID-19 pandemic.
7.	Aruba	The enumeration was extended by weeks/months in 2020.	The use of CAWI, CATI and administrative data was adapted.	The project planning document, publicity and stakeholder outreach were postponed/cancelled due to the COVID-19 pandemic.
8.	Bahamas	The fieldwork was postponed to 2021.	The data collection method was adapted/changed to CATI and CAWI.	The mapping, listing, cartography, questionnaire designing, publicity, procurement and training were postponed/cancelled due to the COVID-19 pandemic.
9.	Bangladesh	The enumeration was extended by weeks/months in 2020.	House listing was adapted/changed to eye estimation and a quick count of the houses.	The mapping, listing, cartography, stakeholder outreach and procurement were postponed/cancelled due to the COVID-19 pandemic.
10.	Barbados	The fieldwork was postponed to 2021	The data collection method was adapted/changed to CAWI.	The pilot census, publicity, stakeholder outreach and training were postponed/cancelled due to the COVID-19 pandemic.
11.	Belize	The fieldwork was postponed to 2021.	The data collection method did not change.	The publicity, stakeholder outreach and training were postponed/cancelled due to the COVID-19 pandemic.
12.	Botswana	The fieldwork was postponed to 2022 or beyond.	The data collection method did not change.	The pilot census, publicity and training were postponed/cancelled due to the COVID-19 pandemic.
13.	Brazil	The fieldwork was postponed to 2021.	The data collection method was	The publicity, stakeholder outreach, procurement and training were

			adapted/change to CATI.	postponed/cancelled due to the COVID-19 pandemic.
14.	Bulgaria	The fieldwork was neither postponed nor stopped.	The data collection method did not change.	The training was postponed/cancelled due to the COVID-19 pandemic.
15.	Cayman Islands	The fieldwork was postponed to 2021.	The data collection method did not change.	The publicity, stakeholder outreach procurement and training were postponed/cancelled due to the COVID-19 pandemic.
16.	Chad	The fieldwork was postponed to 2021.	Other changes and adaptations were made.	The project planning, mapping, listing, cartography, questionnaire designing and pilot census were postponed/cancelled due to the COVID-19 pandemic.
17.	China	The fieldwork was neither postponed nor stopped.	The data collection method did not change.	The project planning was postponed/cancelled due to the COVID-19 pandemic.
18.	Costa Rica	The fieldwork was postponed to 2021.	The data collection method was adapted/changed to CAWI and administrative data.	The mapping, listing, cartography, pilot census, procurement and organization of the data collection process was postponed/cancelled due to the COVID-19 pandemic.
19.	Cote d'Ivoire	The fieldwork was postponed to 2021.	Health equipment was acquired to prevent the spread of COVID-19.	The procurement and training were postponed/cancelled due to the COVID-19 pandemic.
20.	Croatia	The fieldwork was postponed to 2021.		The pilot census and census application were postponed/cancelled due to the COVID-19 pandemic.
21.	Curacao	The fieldwork was postponed to 2021.	The data collection method was adapted/changed to CAWI.	The pilot census was postponed/cancelled due to the COVID-19 pandemic.
22.	Czechia	The fieldwork was neither postponed nor stopped.	Mail delivery, contactless approach and P.O. Box were then adopted.	NA

23.	The Democratic Republic of the Congo	The fieldwork was postponed to 2021.	The data collection method did not change.	The mapping, listing, cartography, pilot census, stakeholder outreach and training was postponed/cancelled due to the COVID-19 pandemic.
24.	Djibouti	The fieldwork was postponed to 2021.	The data collection method did not change as the administrative data was used.	The project planning was postponed/cancelled due to the COVID-19 pandemic.
25.	Dominica	The fieldwork was postponed to 2021.	The data collection method did not change.	The project planning, mapping, listing, cartography, questionnaire designing, pilot census, publicity, stakeholder outreach, procurement and training were postponed/cancelled due to the COVID-19 pandemic.
26.	Dominican Republic	The fieldwork was postponed to 2022 or beyond.	The data collection method did not change.	NA
27.	Ecuador	The fieldwork was postponed to 2021.	The data collection method did not change.	The project planning, mapping, listing, cartography, questionnaire designing, publicity, stakeholder outreach, procurement and training were postponed/cancelled due to the COVID-19 pandemic.
28.	Germany	The fieldwork was postponed to 2022 or beyond.	The data collection method was adapted/changed to CATI.	The project planning and training were postponed/cancelled due to the COVID-19 pandemic.
29.	Greece	The fieldwork was postponed to 2021.	The data collection method was adapted/changed to CAWI, CATI and electronic self-enumeration through a web questionnaire.	The project planning, questionnaire designing, pilot census, publicity, stakeholder outreach, procurement and training were postponed/cancelled due to the COVID-19 pandemic.



30.	Grenada	The enumeration was neither postponed nor stopped.	The data collection method did not change.	The mapping, listing, cartography, publicity and stakeholder outreach were postponed/cancelled due to the COVID-19 pandemic.
31.	Gaum	The fieldwork was postponed to late 2020.	The data collection method was adapted/changed to CATI.	The project planning, publicity and training were postponed/cancelled due to the COVID-19 pandemic.
32.	Hungary	The enumeration was neither postponed nor stopped.	The data collection method did not change. They planned the use of CAWI and the administrative register.	The pilot census was postponed/cancelled due to the COVID-19 pandemic.
33.	Iceland	The enumeration was neither postponed nor stopped.	The data collection method did not change. The use of register-based census has been used from the onset.	The project planning, stakeholder outreach and hiring of experts were postponed/cancelled due to the COVID-19 pandemic.
34.	India		The data collection method did not change.	The publicity, procurement, training and house listing were postponed/cancelled due to the COVID-19 pandemic.
35.	Indonesia	The fieldwork was postponed to late 2020.	The data collection method was adapted/changed to mail (out and back) and drop-off and pick-up.	The publicity, stakeholders' outreach and training were postponed/cancelled due to the COVID-19 pandemic.
36.	Israel		The data collection method did not change.	The project planning, questionnaire designing, pilot census and procurement were postponed/cancelled due to the COVID-19 pandemic.
37.	Italy	The fieldwork was postponed to 2021.	The data collection method was	The project planning, questionnaire designing, publicity, stakeholder



			adapted/changed to administrative data.	outreach, procurement and training were postponed/cancelled due to the COVID-19 pandemic.
38.	Jamaica	The fieldwork was postponed to 2022 or beyond.	The data collection method was adapted/changed to CAWI.	The pilot census, publicity, procurement and training were postponed/cancelled due to the COVID-19 pandemic.
39.	Japan	The fieldwork was postponed to late 2020.	The data collection method was adapted/changed to CAWI and mail (out and back) and drop off and pick up.	The census preparation was not affected.
40.	Kazakhstan	The fieldwork was postponed to 2021.	The data collection method did not change.	The project planning, mapping, listing, cartography, questionnaire designing, publicity, stakeholder outreach and training were postponed/cancelled due to the COVID-19 pandemic.
41.	Kyrgyzstan	The fieldwork was postponed to 2021.	The data collection method did not change. The interviewers used equipment for their protection.	The training was postponed/cancelled due to the COVID-19 pandemic.
42.	Liberia	The fieldwork was postponed to 2022 or beyond.	The data collection method was adapted/changed to CAWI.	The mapping, listing, cartography, questionnaire designing, pilot census, publicity, stakeholder outreach, procurement, training and enumeration phase were postponed/cancelled due to the COVID-19 pandemic.
43.	Liechtenstein	The fieldwork was neither postponed nor stopped.	The data collection method did not change.	The census preparation was not affected.
44.	Luxembourg	The fieldwork was postponed to 2021.	The data collection method was adapted/changed to	The project planning and stakeholder outreach were

			CAWI, administrative data and mail (out and back) and drop off and pick up.	postponed/cancelled due to the COVID-19 pandemic.
45.	Malaysia		The data collection method was adapted/changed to CAWI, CATI, administrative data and mail (out and back) drop off and pick up.	The publicity was postponed/cancelled due to the COVID-19 pandemic.
46	Malta	The fieldwork was neither postponed nor stopped.	The data collection method was adapted/changed to CATI.	The census preparation was not affected.
47	Mauritius	The fieldwork was postponed to 2022 or afterwards.	The data collection method did not change.	The pilot census and procurement were postponed/cancelled due to the COVID-19 pandemic.
48	Mexico	The fieldwork was postponed to late 2020.	The data collection method was adapted/changed to CAWI, CATI, administrative data and mail (out and back) drop off and pick up.	
49	Micronesia (the Federal States of)	The fieldwork was postponed to 2021.	The data collection method was adapted/changed to CATI, administrative data, training of some part of the questionnaire (virtually) and mail (out and back) and drop off, pick up.	The census preparation was completed before the COVID-19 pandemic. However, the post-enumeration survey was replaced with a municipality-focused post-enumeration survey.

50	Montserrat	The fieldwork was postponed to 2022 or afterwards.	The data collection method was adapted/changed to CATI and administrative data.	The project planning, mapping, listing, cartography, pilot census, publicity, procurement and training were postponed/cancelled due to the COVID-19 pandemic.
51	Namibia	The fieldwork was neither postponed nor stopped.	The data collection method did not change. The data collection method was adapted/changed to CATI and mail (out and back) and drop off and pick up.	The mapping, listing, cartography, pilot census, publicity, procurement and training were postponed/cancelled due to the COVID-19 pandemic.
52	Niger	The fieldwork was postponed to 2021.	The data collection method was not changed.	The project planning, mapping, listing, cartography and training were postponed/cancelled due to the COVID-19 pandemic.
53	Northern Mariana Islands	The enumeration was postponed by weeks/months in 2020.	The data collection method was adapted/changed to CATI and mail (out and back) and drop off and pick up.	The publicity, stakeholder outreach, procurement and training were postponed/cancelled due to the COVID-19 pandemic.
54	Panama	The fieldwork was postponed to 2022 or afterwards.	The data collection method was adapted/changed to CATI.	The project planning, mapping, listing, cartography, publicity, stakeholder outreach, procurement and training were postponed/cancelled due to the COVID-19 pandemic.
55	Philippines	The enumeration was postponed by weeks/months in 2020.	The data collection method was adapted/changed to CATI and paper questionnaires with a telephone interview.	The procurement and training were postponed/cancelled due to the COVID-19 pandemic.
56	Poland	The enumeration was neither	The data collection method was adapted/changed to	The census planning was not affected.

		postponed nor stopped.	CATI and other adaptations.	
57	Portugal		The data collection method was adapted/changed to CATI, administrative data, CAWI and implementation of public health procedures.	The pilot census and training were postponed/cancelled due to the COVID-19 pandemic.
58	Puerto Rico	The enumeration was postponed by weeks/months in 2020.	The data collection method was adapted/changed to CATI and mailings.	NA
59	Qatar	The enumeration was postponed by weeks/months in 2020.	The data collection method was adapted/changed to CATI, CAWI, administrative data and mail (out and back) drop off and pick up.	The pilot census, publicity, stakeholder outreach, procurement and training were postponed/cancelled due to the COVID-19 pandemic.
60	Republic of Korea	The enumeration was postponed by weeks/months in 2020.	The data collection method was adapted/changed to CATI, CAWI, administrative data and mail (out and back) and drop off and pick up.	NA
61	Romania	The fieldwork was postponed to 2022 or afterwards.	The data collection method was not affected. The data collection method was adapted/changed to strong publicity	The pilot census and training were postponed/cancelled due to the COVID-19 pandemic.

			for self-enumeration through CAWI.	
62	Russian Federation	The fieldwork was postponed to 2021.	The data collection method was not affected.	NA
63	Saint Kitts and Nevis	The fieldwork was postponed to 2021.	The data collection method was adapted/changed to mail (out and back) and drop off and pick up.	The mapping, listing, cartography, questionnaire designing, pilot census, publicity, stakeholder outreach, procurement and training were postponed/cancelled due to the COVID-19 pandemic.
64	Saint Lucia	The fieldwork was postponed to 2022 or afterwards.	The data collection method was not affected. The data collection method was adapted/changed to CATI, CAWI, mail (out and back) drop off and pick up.	The publicity and training were postponed/cancelled due to the COVID-19 pandemic.
65	Saint Vincent and the Grenadines	The fieldwork was postponed to 2022 or afterwards.	The data collection method was not affected.	The project planning and pilot census were postponed/cancelled due to the COVID-19 pandemic.
66	Saudi Arabia	The fieldwork was postponed to 2021.	The data collection method was not affected. The data collection method was adapted/changed to administrative data and mail (out and back) and drop-off and pick-up.	The enumeration training was postponed/cancelled due to the COVID-19 pandemic.
67	Serbia	The fieldwork was postponed to 2021.	The data collection method was not affected. CATI and CAPI will be implemented.	The publicity, stakeholder outreach, procurement and training were postponed/cancelled due to the COVID-19 pandemic.

68	Seychelles	The fieldwork was postponed to 2021.	The data collection method was not affected.	The mapping, listing, cartography, pilot census, publicity, procurement and training were postponed/cancelled due to the COVID-19 pandemic.
69	Singapore	The fieldwork was postponed by weeks/months too late in 2020.	The data collection method was adapted/changed to CATI and CAWI.	NA
70	Slovakia	The fieldwork was postponed to 2021.	The data collection method was adapted/changed to self-enumeration.	The publicity and training were postponed/cancelled due to the COVID-19 pandemic.
71	South Africa	The fieldwork was postponed to 2021.	The data collection method was adapted/changed to CATI, CAWI and CAPI.	The pilot census and training were postponed/cancelled due to the COVID-19 pandemic.
72	Sri Lanka	The fieldwork was postponed to 2021.	The data collection method was adapted/changed to CAWI.	The procurement was postponed/cancelled due to the COVID-19 pandemic.
73	Thailand	The fieldwork was postponed to 2022 or afterwards.	The data collection method was adapted/changed to CATI, CAWI and self-enumeration.	The training, fieldwork, data processing and dissemination were postponed/cancelled due to the COVID-19 pandemic.
74	Togo	The fieldwork was postponed to 2021.	The data collection method was not affected.	The mapping, listing, cartography, questionnaire designing, pilot census, publicity, stakeholder outreach, procurement and training were postponed/cancelled due to the COVID-19 pandemic.
75	Ukraine	The fieldwork was postponed to 2022 or afterwards.	The data collection method was not affected.	The project planning, mapping, listing, cartography, questionnaire designing, publicity, stakeholder outreach, procurement and training

				were postponed/cancelled due to the COVID-19 pandemic.
76	United Arab Emirates	The fieldwork was postponed to 2021.	The data collection method was adapted/changed to administrative data and self-update of the data.	The pilot census, publicity and self-data update were postponed/cancelled due to the COVID-19 pandemic.
77	The United Kingdom and Northern Ireland	The fieldwork was neither postponed nor stopped.	The data collection method was adapted/changed to CATI and extra telephone capture.	NA
78	United States of America	The fieldwork was postponed by weeks/months too late in 2020.	The data collection method was adapted/changed to CATI and mailing.	NA
79	United States Virgin Islands	The fieldwork was postponed to late 2020.	The data collection method was adapted/changed to CATI.	NA
80	Venezuela	The fieldwork was postponed to 2021.	The data collection method was adapted/changed to CAWI.	The mapping, listing, cartography, pilot census, publicity, procurement and training were postponed/cancelled due to the COVID-19 pandemic.
81	Zambia	The fieldwork was postponed to 2021.	The data collection method was not affected.	NA

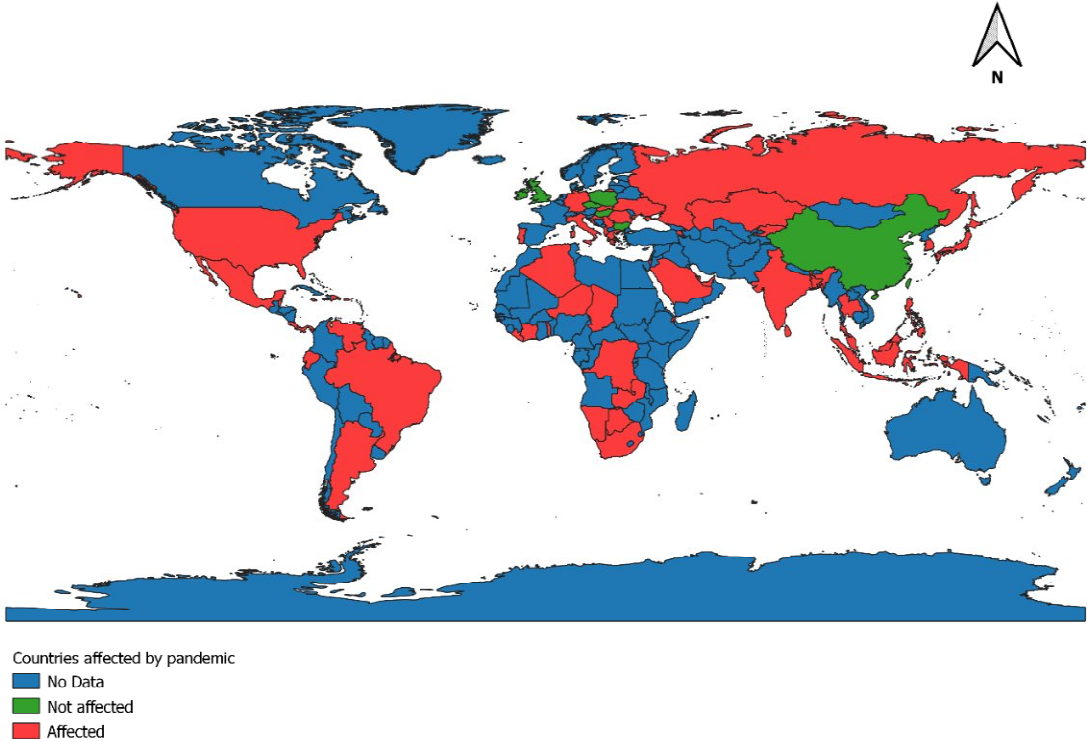
The table listed some census-taking methodologies that some countries have been applying before and during the COVID-19 pandemic. These options can be an adequate way for countries to conduct the census as scheduled, even under crisis.

### **GIS ANALYSIS OF COUNTRIES CENSUS FIELDWORK THAT WERE POSTPONED DUE TO THE PANDEMIC**

To better present an illustrative view of the countries where their census fieldwork were postponed or stopped due to the COVID-19 pandemic by geographical region, a GIS analysis



was carried out using the data in Table 3 above. The table was saved as a CSV file and imported into the GIS environment. A shapefile of administrative boundaries of the world map by countries was obtained and a join analysis was carried out in the GIS environment to join the data in Table 3 to the attribute table of the several countries' boundary shapefile. A map was therefore created using a graduated colour scheme based on if the countries' census processes were affected column as shown in Figure 9 below. More than seventy countries postponed or stopped their census fieldwork due to the public health measures, regulations and restrictions that were declared during the pandemic.



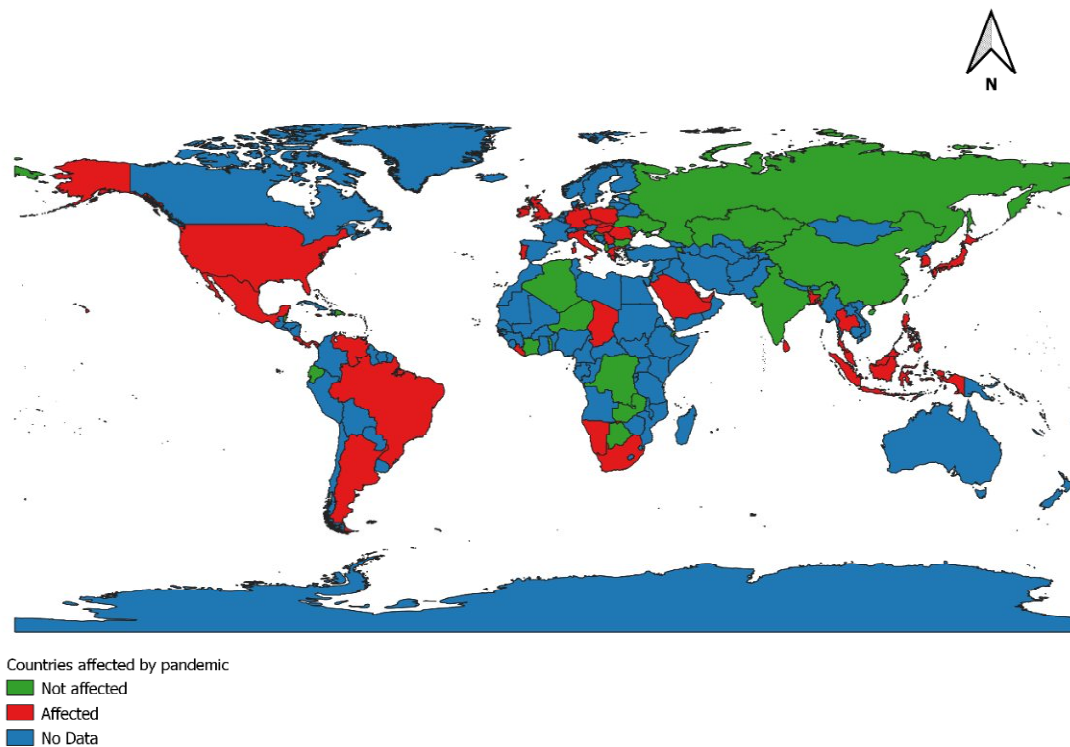
**Figure 9: Showing countries whose census fieldwork were postponed or stopped due to the COVID-19 pandemic by their geographical region**

**GIS ANALYSIS OF COUNTRIES CENSUS FIELDWORK THAT WERE POSTPONED DUE TO THE PANDEMIC**

To better present an illustrative view of the countries that changed their census data collection processes by geographical region, a GIS analysis was carried out using the data in Table 3 above. The table was saved as a CSV file and imported into the GIS environment. A shapefile of administrative boundaries of the world map by countries was obtained and a join analysis was carried out in the GIS environment to join the data in Table 3 to the attribute table of the several countries' boundary shapefile. A map was therefore created using a graduated colour



scheme based on if the countries changed their data collection methods column as shown in Figure 10 below. The data collection methods were changed to either CAWI, CATI, administrative data, mail delivery, fax, mixed methods or implementation of public health measures.



**Figure 10: Showing countries whose census data collection process changed due to the COVID-19 pandemic by geographical region**

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## 2.6 The impact of the COVID-19 pandemic on the census processes

These could be concerning field operations, census mapping, planning, fieldwork execution, the interaction of interviewers with respondents, supervisors with interviewers or other relevant components of census taking, which would have an impact on the census operations. Perhaps, countries that postponed their census might have been due to financial implications of adopting the more advanced methodological options and the consequences of adopting these methods without enough preparation might have affected the quality of the census results. As this might also be the first time those countries are adopting these methods. Some countries lack statisticians with high qualifications that are skilled and can apply these methods. Appropriate ways to collect data, which otherwise would be obtained through house-to-house personal

interviewing (such as using the Internet for households to complete census questionnaires and submit them to the census office; telephone interviewing conducted by census agents.

Other data collection modalities can be utilised to collect census data; thus avoiding the exposure to COVID-19 transmission, which would be associated with a massive house-to-house canvassing by a large number of census interviewers. Data sources, such as vital statistical systems, civil registration systems, education system registrations and others, could be utilized to update/fine-tune population estimates or population counts available from previous censuses or other sources. The statistical methods available for estimating population totals are not options for conducting censuses, rather these estimation methods can help generate estimates aimed to update available information. Likewise, some methods (Rolling Census, continuous registration systems or a combination of thematic administrative registration systems) may be aimed to conduct the census itself including all census phases and components- through more advanced statistical methodologies.

These methods require proper development of institutional as well as technical capacities of professional staff as basic prerequisites, requiring a complex and rather long period. Hence, these might not be immediate substitutes for conducting traditional census at short notice, when the census has been affected by the pandemic. Yet, it is still very relevant to raise these options are desirable goals (in the medium or long term) for a given country. Other categories of recommendations may aim at methodologies geared to solve the difficulties of conducting massive house-to-house interviewing, which under a pandemic situation would fuel the virus transmission. In other cases, the proposed tools may aim to solve constraints related to the availability of updated data, which emerges from the impossibility of conducting a census and generating the necessary updated information, due to the crisis.

## **2.7 Impact of the census postponement on the economy, data and NSO organisation**

Census data are used to estimate and plan the National Social Assistant Scheme, which is usually meant for the disabled, elderly and those that are below the poverty line; however, during a delay in the census, the government will not be able to know the right beneficiaries for the scheme. The beneficiary scheme can include health, housing, education or other social amenities provision, the delay in the census will affect these processes (Jebaraj, 2021). The planning, administration and budgeting of a country's economy will also be delayed in case of

a delayed census. Although the census results of the previous census can be used for the economic planning administration and budgeting, it will not give the actual report of the state of things in the country, and this can lead to the marginalisation of part of the country that needs assistance (Mather, Mark and Scommegna, 2019).

A census is also used to measure the migration trends in a country. It is used to measure the rate of the brain drain or the gain in the socioeconomic status, age, gender and educational status of the migrants as well. This is used to assess the urban and rural areas and how to plan employment creation in different parts of the country. However, a delayed census will also delay this developmental process (Jebaraj, 2021). A census affects congressional redistribution, judicial relief, and constitutional amendments in most countries like the USA (Mather, Mark and Scommegna, 2019).

Delay in the census will lead to delay in the provision of information on redistricting data such as the population by voting age, ethnicity, housing occupancy status and race, which can be to redistrict or redraw legal boundaries (The United States Census Bureau, 2021). The census postponement will adversely impact the assessment of the national developmental policies due to the lack of the 2020 granular census statistics to compare with previous years' census statistics. This will also delay formulating more national development policies to help the country and its residents (The United States Census Bureau, 2021).

The lack of availability of comprehensive and granular 2020 statistics in more than seventy countries such as Algeria, Bahamas, and Ecuador has led to a lack of accurate data used for planning services delivery, implementation of the SDG goals, and budget allocation (United Nations Department of Economic and Social Affairs, 2021). The census delay will also affect the NSO office adversely as there will be no adequate data for their operations and planning purposes (United Nations Department of Economic and Social Affairs, 2021).

## **2.8 Other impacts of the COVID-19 pandemic**

The seventeen sustainable development goals have 169 targets and over 230 indicators (United Nations, 2021). To achieve this goal by 2030, there is a need to regularly monitor the progress made in different countries with censuses (UNSD, 2020). Monitoring the SDG goals to ensure completion by 2030 will be affected by the delay in a census caused by the pandemic (United Nations, 2021). Due to the lockdowns in more than seventy countries, the census process and SDG goals are affected negatively (United Nations, 2021). COVID-19 has also increased the rate of physical, sexual, psychological, economic and emotional violence (Fapohunda *et al.*, 2021). Most victims were forced to stay with their perpetrators, probably family members or

spouses, throughout the lockdown (Fapohunda *et al.*, 2021). This will cause ripple effects of the increase in emotional trauma, illness, physical pain, low self-esteem, and death (Fapohunda *et al.*, 2021).

The COVID-19 pandemic also adversely impacted South Africa's already strained healthcare system (Matatiele, Stiegler and Bouchard, 2021). The health workers were overwhelmed during the pandemic, and their focus was on mitigating the pandemic, which will affect chronic illnesses management such as TB, HIV, and AIDS (Matatiele, Stiegler and Bouchard, 2021). Other health effects of the pandemic are brain fog, depression, isolation from loved ones, long-term health complications, anxiety, and sleep disorders (Saladino, Algeri and Auriemma, 2020). The usual health administration processes such as immunization, maternal and child health care, tuberculosis treatment and other treatment were disrupted (Chriscaden, 2020).

The economic effects can lead to loss of jobs, reduction in revenue of several countries, business shutdown, malnutrition, hunger and extreme poverty (A Pak, O Adegboye, A Adekunle, K Rahman, E McBryde, 2020). The effect of pandemics and epidemics on demography is that it has increased inequality, mortality rate and delays in the census process of about seventy countries (Saladino, Algeri and Auriemma, 2020). The governments of different countries prioritise public health responses to COVID-19 and reduce the economic impact on their citizens; hence, the funds meant for the census are diverted to meet this need (Chriscaden, 2020). This also led to census postponement in different countries such as Brazil, Seychelles, Belize, and more (United Nations, 2020). If the detrimental consequences of the COVID-19 pandemic on the economy of different countries increase, the census operation shortfall will increase (United Nations, 2021c).

The COVID-19 pandemic also adversely affected the food supply chain, leading to a confrontation with security forces and several riots (Stiegler and Bouchard, 2020). Before COVID-19, there were liberal migration laws in South Africa that would increase the country's brain gain to attract intellectuals which would help the country (Kanayo, Anjofui and Stiegler, 2019). However, the brain gain rate in South Africa will reduce due to the COVID-19 effects, economic problems, and xenophobic attacks (Ogujiuba Kanayo, Patience Anjofui, 2019). Hence, there is a need for global financial support mobilization for population data collection and the census. The significance of the census is stated below.

## **2.9 Significance of a census**

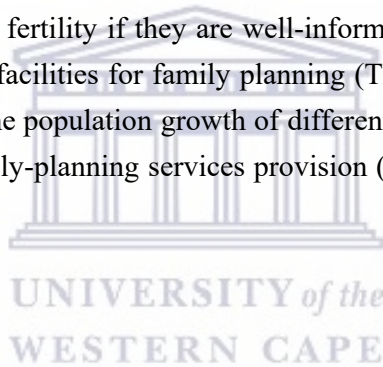
A census aims to count the whole population of a country and the place of residence, education, living situation, age and sex of each person (U.S. Census Bureau, 2017). The economic, social

and demographic information of the population will also be collected (Stats SA, 2015). The census helps get statistical data on a country's population, informing decision-making at all levels (both private and government sectors) (Stats SA, 2015).

Household surveys are used to get data on the workforce, housing, health, transportation and agricultural production and other population characteristics of a country. Censuses are basically to determine the fertility rate, mortality rate, marriage, divorce, reproductive health, population structure, and country distribution (Measure Evaluation, 2017). Also, they are a guide for the distribution of a country's funding for various crucial programs (Staff, 2020).

**a. Population growth**

The world is overpopulated, with more than 7.9 billion people globally (Woldometer, 2021). However, about 130 million children are born annually, an approximation of 250 children per minute and most of this is from developing countries (Lamble, 2018). If deliberate action is not taken, the population of developing nations such as India, the Democratic Republic of Congo, Nigeria, Bangladesh, and Ethiopia will reach 10 billion by 2057 (Woldometer, 2021). However, women can control their fertility if they are well-informed about family planning, and there are also available health facilities for family planning (The open university, 2021). Censuses provide information on the population growth of different parts of a country, which will help the government plan family-planning services provision (The Council of Economic Advisers, 2000).



**b. Population structure**

Census data sets often provide the most accurate age structure of different countries to the village level (The Council of Economic Advisers, 2000). This helps decision-makers know where to build more hospitals and schools and create more jobs (Statistics South Africa, 2019). This is dependent on the age structure of each region's residents (percentage of children and adults), determining the employment and unemployment rate (Statistics South Africa, 2019).

**c. Modernisation of education and training**

Despite the significant increase in the completion of primary school education spurred by the millennial development goals, secondary school enrolment in sub-Saharan Africa is 40%. This has led to sub-Saharan Africa having limited capacity for innovation and research, yet this is a condition for creating a smart, knowledgeable and modern economy in this century. There is a need for timely, reliable and accurate data on the age, gender, income, disability, geographic

location, migratory status and other data that are relevant to the national context to generate national population projections and plan the future of each country in all its diversity.

**d. Transformation**

An accurate census will better help the government plan for a non-racial, democratic, prosperous and non-sexist generation (U.S. Census Bureau, 2017). It helps the government plan amenities allocation. It also helps the government allocate federal funding to hospitals, schools, public works, jobs, roads, and other social amenities in different states and provinces (U.S. Census Bureau, 2017). The allocation of these federal funds is solely dependent on the province or state's population, age group, living conditions, sex and other characteristics (U.S. Census Bureau, 2017).

**e. Job creation**

An accurate census will help the government strategize the recovery and reconstruction plan for job creation in all states and provinces (Staff, 2019). The census provides a database for the workforce and population projection in a country and promotes equity and equality (Staff, 2019). A census is used to determine the conditions of social and economic enterprises in terms of their workforce size (by nationality and gender), economic activities and legal status (W.P., 2019). It is usually used to determine different phenomena in a country such as mortality, fertility, migration and other post-census population and population growth rates (W.P., 2019). Additionally, the census is used to allocate political power and civil rights responsibility (Measure Evaluation, 2017). Some countries' SDG significances in the census are explained below.

**2.10 Significance of census to the sustainable development goals (SDG).**

An accurate and timeous census process will also aid the accompaniment of the SDG. A census provides economic, demographic and social information about a population (UNSD, 2017b). Censuses are used to monitor the SDG goals and generate some SDG indicators. Without accurate, appropriate and timely monitoring of the SDGs with a census, meeting the goals will not be feasible (UNSD, 2017a). A census gives detailed information on the most vulnerable population of the SDG indicators by age, sex, geographical regions, income, race, ethnicity, disability and migration status (population mobility, internal migrants and internally displaced persons) (Statistics South Africa, 2019).

It provides data for twelve of seventeen SDG goals such as poverty eradication (SDG one), health (SDG three), education (SDG four), Gender equality and women empowerment (SDG



five), sanitation and clean water (SDG six), modern and affordable energy (SDG seven), growth and employment (SDG eight), innovation, industry and infrastructure (SDG nine), inequality reduction (SDG ten), sustainable communities and cities (SDG eleven), disaster management and climate change (SDG thirteen), peaceful societies (SDG sixteen) and management of the goals (SDG seventeen) (UNSD, 2017a).

The indicator of poverty alleviation (SDG one) that can be derived from the census are:

- The proportion of women, children and men of all ages according to the national definition.
- The proportion of the population that are living in houses with basic services accessibility. - Proportion of population below the international poverty line by age, sex, geographical location (urban or rural) and employment status.
- The proportion of the population that is living below the national poverty line by age and sex

The indicators for good health/ well-being (SDG three) that can be derived from the census are health professionals and workers density and distribution, maternal mortality rate, under-five mortality rate, the birth rate in adolescents (10-14 years) and birth rate in women of 15 - 19 years per 1000 (UNSD, 2017a). The indicators for a good education (SDG four) that can be derived from the census are participation in Pre-School learning, the proportion of children and teachers at different school levels and the proportion of children that achieve proficiency level in numeracy and literacy skills by sex and age group (UNSD, 2017a).

The indicators for gender equality (SDG five) that can be derived from the census are: Proportion of females between the ages of 20-24 years who got married before 15 -18 years and the Proportion of women that are in managerial positions (UNSD, 2017a). The indicators for sanitation and clean water (SDG six) derived from the census are the proportion of households with safe drinking water and the proportion of households with safe sanitation services (UNSD, 2017a).

The indicators for modern and affordable energy (SDG seven) derived from the census are the proportion of households with electricity supplies and the proportion of households with technology and clean fuel (UNSD, 2017a). The indicators for economic growth and decent work (SDG eight) that can be derived from the census are the proportion of children in child labour by sex and age between 5 -17 years, the proportion of youths that are not in training, employment and education aged 16 – 24 years and unemployment rate by sex, disabilities and age (UNSD, 2017a).

The indicator for innovation, industry and infrastructure (SDG 9) derived from the census is the proportion of manufacturing employment (UNSD, 2017a). The indicators for sustainable cities (SDG eleven) that can be derived from the census are the Proportion of people living in

the slum, inadequate housing and informal settlements. A slum is defined as a place that lacks access to safe water and adequate sanitation, durable housing with a permanent structure and tenure security to prevent forced evictions (UNSD, 2017a).

The indicators for inequality reduction (SDG ten): derived from the census is the proportion of income, educational attainment, poverty gap and economic disparities by sex, age, disability, religion, economic, race, origin, ethnicity and other statuses in the country (Eurostat, 2022).

The indicators for disaster management and climate change (SDG thirteen) derived from the census is the proportion of climate education in rural and urban areas and institutional and human capacities for the mitigation of climate and adaptations (United Nations, 2021a).

The indicators for peaceful societies (SDG sixteen) derived from the census is the proportion of domestic violence, birth rate, death rate with the causes and proportion of insecurities and war (United Nations, 2021b).

The indicators for the partnership for the goals (SDG seventeen) that can be derived from the census are the proportion of countries that conducted housing or population census in the last ten years and the proportion of countries that have achieved 80% death registration and 100% birth registration (UNSD, 2017a).

#### **a. Decent work and economic growth**

Over seventy countries postponed their census due to the pandemic in 2020 (United Nations, 2020). A well-conducted census will help the government project and plan adequately using the census data, thus, improving work conditions and the economy in alignment with SDG eight (The Council of Economic Advisers, 2000).

#### **b. Gender equality**

Accurate census data, especially during a national crisis, such as domestic violence amid the pandemic, would help policymakers adequately plan interventions and mitigate gender inequality (SDG five) (UK Data Service, 2015).

#### **c. National data system**

A timely and accurate census data helps strengthen the capacity of national statistics offices and other offices that are responsible for population data production and dissemination. Accurate census data also provides the right foundation for economic and social development to achieve transformative results. Population census provides legal identity for every individual and ensures that no one is left behind. It helps promote human rights principles, peace, and



equality and helps create a conducive environment for everyone to realise their potential, especially providing the basic needs for this as peace, equality, and justice are bedrock for the SDG goals. Population data are needed in African countries to locate settlements in remote areas, identify and support the needy and hold their governments accountable.

**d. Improving individual freedom and rights**

Census data help improve gender equality and human rights assurance, especially for girls and women. It also helps eliminate discriminatory practices such as child marriage, gender-based violence, female gender mutilation, or other harmful practices. The prevalence of female gender mutilation and its causes are measured with population data. This is to monitor the subnational data decline for different countries. The census and survey data also provide information on the percentage of women that can decide on their reproductive health, uptake of family planning and women empowerment in different countries. This will, in turn, help monitor the SDG metrics on women's rights.

**e. Poverty alleviation**

An accurate and timely census will help the government plan the social assistance system and national development to aid poverty alleviation and economic growth. Business owners usually use information from the census to determine how to run their businesses, where to expand their operation, open new stores, the goods to produce, how to distribute these goods, and the location of their target audience (Authority, 2011). It also provides a database for specific occurrences such as domestic violence, level of educational attainment, employment rate or unemployment rate in a province or state (Authority, 2011). It provides frameworks for getting samples for field research in the future (U.S. Census Bureau, 2017). It provides the status and features of present houses to the public (private and government sectors) to aid future construction plans (Authority, 2011).

## **2.11 Census process (How to conduct a census)**

The types of census processes are CATI, CAWI, statistical register and the traditional census process. The traditional census process (house-to-house enumeration) is commonly used. They are further explained below.

**a. CATI method**

This involves the use of telephone interviews to collect the required information for the census (Elliott, 2020). For the CATI method, the telephonic interview is conducted with preplanned

questionnaires and phone calls for census purposes (David Chapman, 1990). The conversations are recorded, transcribed and cross-checked to ensure accuracy in data collection (Elliott, 2012). Compared to the traditional method, the CATI method is less expensive, intensive and efficient. Also, they are faster (not time-consuming) (Barr *et al.*, 2008).

**b. CAWI method**

This involves using web-based questionnaires through the internet for the data collection process for census processes (Elliott, 2012). Some advantages of the CAWI method are that the process is less expensive, easy, and faster to collect and analyze than the traditional census process (Elliott, 2012). Nevertheless, the disadvantages of the CAWI method are that some target populations may not have an internet connection, smartphones, laptops or other electronic gadgets access (and these are crucial tools for the method) (Census Bureau, 2016). Also, errors on the online questionnaires cannot be easy to correct (Stats SA, 2018).

**c. Register-based census system using statistical register**

This involves using an administrative register to collate all the required social, demographic and economic information about a country's population (Daas, P and Fonville, 2007). The aim of keeping a population register is to have updated information about a population (Daas, P and Fonville, 2007). These registers are used to collect valuable information on people, their addresses, businesses and activity such as birth, death, marriage, divorce, employment and more (Wallgren and Wallgren, 2016). A statistical register has four parts: population, address, business, and activity register (Wallgren and Wallgren, 2016).

The population registers are used to collect social, demographic and economic information about the country's residents (United Nations Statistics Division, 2012). The address register is used to collect information on the dwellings/address of the country's residents (Office for National Statistics, 2011). The business register is used to collect information on different businesses in the country (Australian Bureau of Statistics, 1997). The activity register contains information on the different activities of the country's residents. Activities include employment, labour markets information and study (Office for National Statistics, 2011).

The advantages of the statistical register are that they are a continuous type of data collection that helps provide an update about the population even in times of health or national crisis (UNECE, 2019). Some countries, such as Poland, Estonia, Greenland, Finland, and Belize, use statistical registers for their census update (Vale, 2013). At the same time, the decennial censuses information that may be outdated after some years (UNECE, 2019). Additionally, information about the country's residents will be easily updated (The Republic of Pakistan,

2008). The population records can also be linked through their lifetime, aiding research purposes (Vale, 2013).

Some disadvantages of using a statistical register are that the data type available depends on the administrative department responsible for the collection (D.Timofte, A. Stoian, R. Hainarosie, C. Diaconu, D. Iliescu, G. Balan, 2018). Events that occurred before the registration or while the person is abroad might be excluded (Penneck, 2007). The quality in a different region, province, state or department might be unequal, bringing about a lack of homogeneity (Penneck, 2007). Also, there are some concerns about potential data leaks (D.Timofte, A. Stoian, R. Hainarosie, C. Diaconu, D. Iliescu, G. Balan, 2018).

#### **d. The traditional process of the census**

This process involves a house-to-house enumeration of the population's social, demographic and economic information (Statistics South Africa, 2004). Also, information on the type of housing, house facilities and the number of house occupants and family members is collected (Statistics South Africa, 2004). For the process of conducting a census, the most important rule is homogeneity to prevent bias (Baffour, King and Valente, 2015). Homogeneity means the data should be collected in the same way: the same questionnaires, the same questions, the same time of collection, the same data collection process, the same training for the workers, the same collection tools and capturing processes (Baffour, King and Valente, 2015).

This household census aims to determine accurate information on demographics, the fertility rate (including birth and death), employment rate, all types of mortality rates (maternal, infant, crude, under five and age-specific mortality rates) and morbidity (Statistics South Africa, 2018). The Project Manager will ensure that the questionnaire correlates with the aims and objectives of the census (Statistics South Africa, 2018). The census will include steps like study preparation, pilot census, census schedules, organization, recruitment process, mapping out territories, questionnaires formulation, data collection, collation and dissemination (Baffour, King and Valente, 2015). Some of the census staff are the project manager, specialist, project assistant, supervisor, team leader and enumerators (Food and Agriculture Organization of the United Nations, 2021a). All these census processes and census staff roles are explained below.

##### *i. Study preparation*

Findings would be made about the country and its population before the commencement of the census (UN, 2008). The Project Manager and other team members will have to find out about the religion, culture, language, politics and other systems of the different districts and

provinces in the country (Forecasting and research division, 2015). This will help prevent mistakes in the census (Statistics South Africa, 2021b).

*ii. Pilot census*

A pilot census is usually conducted for four to five months before the actual census to check for errors in the questionnaire and see where proper improvements and corrections can be made before the actual census commences (Food and Agriculture Organization of the United Nations. The data entry process and the data analysis will also be tried with the pilot census (Statistics South Africa, 2021a). The pilot census is important because there is not enough time to make mistakes during the main census because of the seasonal change (summer to winter) (Statistics South Africa, 2021b).

*iii. Census schedule*

The census must also be implemented in a specific, limited period, and the data collection process must be the same at all times of the field phase to ensure homogeneity. The time of the census will be based on information gathered on climate. The best time to conduct the census is during summertime, preferably in any country. The census will be scheduled for a short time to ensure that it is conducted in favourable weather conditions and to maintain the homogeneity of the collected data.

*iv. Census organization*

The census team will be built from the Project Manager to the enumerators based on the type of the census, the length of the questionnaire, and the country's population size. The recruitment process involves advertisement, selection, test and final selection. Also, the staff will be trained close to the census process (Food and Agriculture Organization of the United Nations, 2021a). They will be trained with the same procedure to ensure homogeneity (Statistics South Africa, 2021c). The staff members will include the project manager, specialist, project assistant, supervisor, team leader and enumerators (Food and Agriculture Organization of the United Nations, 2021a).

*v. The census recruitment process*

The Project Manager will oversee the recruitment of specialists and project assistants. The project assistant will recruit the regional supervisor, and the regional supervisor will recruit the provincial and district supervisors (Office for National Statistics, 2001). The supervisors will then recruit the team leaders and enumerators (Food and Agriculture Organization of the United Nations, 2021a). The recruitment process will not be based on knowing the person before, but it will be based on merit and passing the test (Office for National Statistics, 2001). Project Managers, specialists, project assistants, supervisors, team leaders and enumerators will also

be recruited for the census process; their roles are explained below (Food and Agriculture Organization of the United Nations, 2020b).

❖ Project manager

The Project Manager will oversee the whole census process from the implementation phase to the data analysis (Office for National Statistics, 2001). The Project Manager will have to study the political, geographical, ethical, economic, and religious situation of the country to avoid any unnecessary mistakes during the census and will also have to train staff about the knowledge of the country, questionnaire questions and other processes (CZSO, 2021). The Project Manager will also state the budget, calculations that are to be made and the type of data that should be captured and organize the sampling process (Food and Agriculture Organization of the United Nations, 2020b).

❖ Specialist

She /He will manage different aspects of the census and will refer to the project manager (Food and Agriculture Organization of the United Nations, 2020b).

❖ Project Assistant

The project assistants will support the project manager in the different administrative processes of the census (Forecasting and research division, 2015). They play a huge role in the success of the census process (CZSO, 2021).

❖ Supervisor

Several supervisors will be hired to oversee the census process at the regional, province and district levels (Food and Agriculture Organization of the United Nations, 2020b).

❖ Team leader

The team leaders will work alongside the enumerators for the data collection process and oversee the enumerators ensure the homogeneity of the data that will be collected (Office for National Statistics, 2001). They must check the questionnaire to see if the information is completed. In cases when the information is not completed, they will ask the enumerator to go back to the household to complete them (Office for National Statistics, 2001).

❖ The enumerators

The enumerators are involved with the direct collection of census data from house to house. The quality of the data is dependent on their work (Forecasting and research division, 2015). The recruited census personnel must be able to read and write the language fluently, be friendly,

emotionally stable, accept what the people say, and be adaptable, neutral, patient and sensitive (Forecasting and research division, 2015).

The supervisors will ensure that enough female enumerators work on the census (50/50 ratio for the male and female enumerators) (CZSO, 2021). It is expedient that all enumerators understand all the census questions in the questionnaire to ensure proper explanation to the household members about the essence and the importance of the data (Food and Agriculture Organization of the United Nations, 2020b). There is a need for training of the enumerators on the questionnaire content (CZSO, 2021).

*vi. Mapping out territories*

A minimum of 100 to a maximum of 250 households will be allocated to each enumerator (Clague, 2001). The household allocation will be illustrated on a map to indicate different territories that each enumerator or group of enumerators will have to cover (Clague, 2001).

*vii. Questionnaire formulation*

One type of questionnaire is generally used in all households (Department of Statistics, 2011). The household questionnaire is incorporated into the individual questionnaire. Only the relevant questions will be in the questionnaire, and the questionnaire's pages must not exceed four pages (Department of Statistics, 2011). This is to prevent the collection of unnecessary information, increase the participants' response rate, and encourage the participants' willingness to answer the questions with rapt attention (Food and Agriculture Organization of the United Nations, 2015).

For all the households in the country, only the head of the family will be permitted to answer the questions in the questionnaires to ensure the homogeneity of the census (Feeney and Feeney, 2019). The paper questionnaire will be used for this census (Department of Statistics, 2011). Although it would be easier to use a tablet using the computer-assisted personal interviews (CAPI) method for the data collection, there is a lot of security risk in using that method. Also, some of the tablets can get stolen, which will affect the homogeneity of the results (Department of Statistics, 2011).

The same questions will be asked in the same way to everyone to ensure that the data is homogeneous (Food and Agriculture Organization of the United Nations, 2015). The questionnaire will contain a long and short table with open and closed questions to prevent monotony (Feeney and Feeney, 2019). The questionnaire will be simple and easy to understand to aid the data collection process (Department of Statistics, 2011). The questionnaires will be designed using a quantitative approach.



A quantitative approach will be considered because the answers can easily be converted to qualitative answers if need be, but a qualitative answer cannot be converted to a quantitative answer and may sometimes not be easy to interpret (Feeney and Feeney, 2019). The questionnaire will contain many closed questions to ensure easy interpretation (Feeney and Feeney, 2019). Once the census is over, the paper questionnaire will be scanned, cleaned and captured for processing before disseminating the results (Food and Agriculture Organization of the United Nations, 2015).

**e. Census operations**

There are three major types of census operations: preliminary work, conducting the census, and data obtaining and processing (Anahit, 2014). The census process includes the holistic process of compiling, collecting, evaluating, analyzing, disseminating and publishing statistical data on housing or population in a geographical area (Ministry of Development Planning and Statistics, 2020). The characteristics of a population include economic, demographic and social data provided at a reference period (Ministry of Development Planning and Statistics, 2020).

**f. Census methods**

The types of census methods are the de facto and de jure methods (Divisha, 2021). The de facto method conducts the enumeration of the individual based on their location on the day of the census and not based on where they usually reside before the census (Oxford University Press, 2015). The de jure method conducts the enumeration of the individual based on where they reside, regardless of their location on the census day (Oxford University Press, 2015).

**g. Demerits of the census process**

The census process is time-consuming, and it takes many procedures to complete. It also requires manpower to collect (Toppr, 2020). The census process is also very costly because it requires a thorough check of statisticians before collecting the data (The United States Census Bureau, 2016). The census must be thoroughly checked to avoid errors as there is a great possibility of errors (States and Islands, 2016). Also, census errors can occur due to a lack of precision of statistical terms, measurement errors, non-response and personal bias from the enumerators (Toppr, 2020).

Information on domestic violence is not included in the census questionnaire globally despite the daily increase in the phenomenon (Fapohunda *et al.*, 2021). Perhaps, asking questions about domestic violence will inform the government of the occurrence rate and this will help the

government to focus more on women's empowerment and girls' education in a particular part of a country as compared to others (Fapohunda *et al.*, 2021).

## **2.12 Census political interactions and dependence**

The significance of the census was explained in the last section; the census and political interactions are explained in this section, from staffing issues to results suppression or expansion to results falsification and delay in the release of the results. Censuses are subjected to political interference in countries as incentives were given to census officials to inflate the population figures for different states (Akinyemi, 2020). This is to get more government funds, resource allocation and political representation (Wallace, 2020).

### **a. Staffing issues**

Census officials' professional integrity and independence are sometimes attacked. This has sometimes led to death, arrest, disappearance, dismissal, or forceful resignation of the officials. Senior officials are more vulnerable and visible to political leaders than their junior colleagues. Political leaders might also employ more census officials that accept their ideology. Also, the danger of hiring less-qualified personnel may arise, reducing the public perceptions of the agency's professional acumen (Akinyemi, 2020).

### **b. Suppression or expansion of statistical field data collection**

Suppose a new political leader declares a 'war on unemployment. In that case, the country's statisticians will concentrate more on collecting data related to employment and unemployment rate in different parts of the country. This will cause an expansion of employment and unemployment data and suppress other data types. Some of the census results and credibility are questioned if the process was sponsored by a business trade group or other firms (Praia City Group, 2020). Likewise, a statistical agency can be redundant if every data collection and dissemination decision is subject to the approval and debate of political leaders. This decision is also subject to political impartiality and conflicts. Statistical officials can be in the middle of scientific and political controversies (Wang, 2012).

### **c. Falsification of census data**

Statistical offices of countries are sometimes under pressure to present economic and social development; this often causes the dissemination of inaccurate results and data falsification (Serra and Jerven, 2021). The census officials can also fabricate the census data by answering the census questionnaires themselves to meet up with some presumed census results and save



time. For instance, in the 1970's population census in the Central African Republic, under the desires of President Bokassa, the census results were inflated (Prewitt, 2005). This led to complexities of the results as the breakdown of the women and men population did not add up to the given totals. Non-statisticians also detected these errors easily (Schneider, 2020).

**d. Politically motivated data suppression**

The result of a census can be suppressed if the results are damaging politically to political leaders and threatening to state security. Examples of census suppression include China's 1960 census cancellation and the annual statistical communique (Aird, 1982). The suppression lingered till 1979 when the statistical communique publication resumed. There were also similar issues of census suppression in Russia and Romania in 1933-1956 and 1980, respectively (Medvedkov, 2017). The head of the census for the 1937 population census in Russia was arrested, and there was total suppression of the census results (Medvedkov, 2017). The US census in the 1970s was asked to remove "poverty" from their reports (Prewitt, 2005). The primary reason for the census suppression was the state secret that the results revealed (Prewitt, 2005).

**e. Delay in the census results dissemination**

Statistical agencies in other Eastern European countries and former USSR cultures were to publish true but exaggerated reports of growth (Moshe, 2014). Also, political leaders can manipulate the timing of the dissemination of the census results (Food and Agriculture Organization of the United Nations, 2021b). They would prefer to announce the good results before the election and the bad results after Election Day to aid the campaign decision of the party in power. Generally, in countries, the official statistical system's professional independence and integrity are established as a law or policy in the Royal Statistical Society Official Statistics Working Party (UK) and the United Nations Handbook on Statistical Organisation (United Nations. Statistical Division., 2003).

However, an exceptional appeal for the statistical agency to delay disseminating the census results for a state purpose that is well defined rather than for political reasons can be accepted (United Nations. Statistical Division., 2003). For instance, the publication of the oil import data must have been delayed during the energy crisis in the Netherlands in 1937. The trade statistics were kept secret during World War 2 in US and Canada (Moshe, 2014).

### **2.13 Concluding summary**

Chapter 2 explains the literature review perspective of the census and how the current health crisis has affected it. The next chapter will further discuss the results, analysis and discussion of this study.



## CHAPTER 3: ANALYSIS AND RESULTS

The previous chapter explains the literature review and significance of this study. This chapter will further discuss the analysis, results and discussion of this study.

### 3.1 Analysis

The study analysis included processes like removal of duplicates, abstract screening, full-text assessment, data extraction, data synthesis and findings presentation. The Embase, Scopus, web of science, Ebscohost, PubMed and grey literature was searched with the use of Boolean operators (such as or & and).

#### a. Duplicates removal

The search results were uploaded to endnotes, and the duplicates were removed and uploaded to Rayyan for the abstract screening and other crucial processes.

#### b. Abstract screening

After the search and duplicate removal, 17126 articles were uploaded to Rayyan for the abstract screening. The abstract screening involves reading the title and abstract of each study on Rayyan and comparing it with the study's eligibility criteria to decide whether to include or exclude the article from the study.

#### c. Full-text assessment

After the abstract screening of the articles, it was discovered that only a few studies had been conducted on how the census was conducted after a national or health crisis. The included articles were fifty, with 17,054 articles excluded and 22 under the maybe categories. Subsequently, after the full-text assessment (reading) of the seventy-two (included and maybe articles) was conducted. The full-text assessment involves reading the full pdf of the articles and comparing them with the eligibility criteria. This ensures that the right articles are included, and the right information from articles is extracted for the study.

#### d. Data extraction

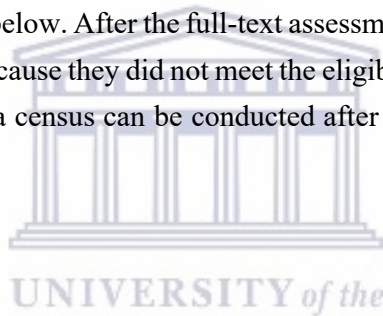
After the full-text assessment, eighteen studies were included in this study because they met the eligibility criteria, and fifty-four articles were excluded. Successively, the data extraction of the eighteen included studies was conducted. The information extracted from the study is

author, study title, author, year of publication, data collection method, country, health or national crisis year and reviewer's comments.

**e. Included and excluded studies (Study results)**

After the full-text assessment of seventy-two studies, eighteen were eligible for inclusion in this study since they met the eligibility criteria, which is the discussion of how a census can be conducted after an epidemic, pandemic or national crisis. The studies were conducted on six continents and twenty-six countries. This includes the USA, Australia, The Netherlands, New Zealand, Brazil, China, Denmark, Estonia, France, Germany, Italy, Malaysia, Philippines, Qatar, South Korea, Sri Lanka, Sweden, Taiwan, Thailand, UEA, UK, Vietnam, Minneapolis, Cameroon and Switzerland. Two of the studies were multinational studies as they were conducted in more than one country.

The included studies suggested the use of the following methods CATI, CAWI, email, mail, fax, population registers and GIS can be adopted for conducting population and housing censuses after a national crisis, epidemics and pandemics. The included studies are further explained in the discussion section below. After the full-text assessment of seventy-two studies, fifty-eight studies were excluded because they did not meet the eligibility criteria for discussing the study outcomes, which is how a census can be conducted after an epidemic, pandemic or national crisis.



**3.2 Discussion**

This section gives information on the included studies, such as the reason for inclusion, study title, Author's names, year of publication, study country and a health or national crisis. Also, the methods, results and how these studies correlate with our study objectives (i.e. how to conduct a census during and immediately after a national or health crisis) are explained below to draw inference for our results.

“A census of Medicolegal Death Investigation in the United States, a need to Determine the State of our Nation's Toxicology Laboratories and Their Preparedness for the Current Drug Overdose Epidemic” discussed the use of a mixed method for their census data collection approach. The methods include email, mail, web and CATI to send the questionnaires, and the responses were received via fax, mail, web and CATI. The response and non-response rates were later evaluated, and the results were also analysed. Substantial results were gotten from the collected data on the country's Preparedness for the current epidemic (drug overdose) and ways to address it. In conclusion, the mixed method of data collection such as CATI, fax, mail,

email and web-based questionnaires and response can also be employed for a census during and right after an epidemic, pandemic, health or national crisis (Ropero-Miller *et al.*, 2020).

“Pandemic influenza in Australia, using telephone surveys to measure perceptions of threat and willingness to comply” discussed the use of the CATI method to assess the threat, preparedness and compliance willingness during the influenza pandemic. About 2081 adults were interviewed, and their responses were used to measure the state of the population. The collected data was useful in assessing the behavioural pattern of the population during public health threats and their willingness to comply. The CATI method is a useful tool for census data collection during health or national crisis. As this will also help reduce the spread of the epidemic or pandemics that are infectious diseases, the CATI method can be a much safer census data collection method (Barr *et al.*, 2008).

“Acute myocardial infarction incidence and hospital mortality routinely collected national data versus linkage of national registers” discussed the use of hospital registers collected from 1995 to 2005 to estimate the incidence of acute myocardial infarction in the country. The estimate of the acute myocardial infarction incidence and hospital mortality was gotten. The prevalence in men and women was also assessed between 1995 to 2005. The results were accurate and not biased as the double counts and recurrent events were excluded. In conclusion, using a population register is an accurate tool for estimating a country's population (census processes) (Koek *et al.*, 2007).

"Anonymous linkage of New Zealand mortality and census data" discussed how mortality and census records were used to investigate the socioeconomic and demographic mortality gradient of New Zealand. The mortality and census records between 1991 to 1994 for the 0-74 years age group were assessed. The mortality rate by socioeconomic status, age, sex and ethnic group were assessed. In conclusion, vital statistics and registers can be used for census purposes to monitor population statistics (Blakely, Woodward and Salmond, 2007).

"Births, marriages and deaths, provisional data for March 1999" discussed the recorded statistics of marriage, divorce, deaths, live births rate, natural increase and population base in the U.S.A from January 1998 to March 1999. This serves as an example of how census data are collected for future purposes as the population rates are estimated monthly, which can also be likened to the use of the population register for census purposes (NCHS, 2000b).

"Births, marriages and deaths, provisional data for August 1999" discussed the recorded statistics of marriage, divorce, deaths, live births rate, natural increase and population base in the U.S.A from January 1998 to August 1999. This serves as an example of how census data

are collected for future purposes as the population rates are estimated monthly, which can also be likened to using the population register for census purposes (NCHS, 2000a).

"Deafness as an epidemic disease in Australia (A note on census and institutional data collection)" discussed deafness as a health crisis (epidemic). A register was used for data collection during this epidemic in Australia. Likewise, taking inferences from this study, the population register can be used for census purposes and monitoring the statistics of the population over time (Lancaster, 1951).

"Comparison of crowd-sourced, electronic health records based and traditional healthcare-based influenza tracking systems at multiple spatial resolutions in the USA" discussed the assessment and comparison of five surveillance systems for influenza and the correlations between the systems were calculated for four influenza seasons between 2012 to 2016. Results show that surveillance systems can be used to complement traditional healthcare-based systems. Taking inference from this study, the population register can be used for census purposes and monitoring the statistics of the population over time (Baltrusaitis *et al.*, 2018).

"A methodology for small area prevalence estimation based on survey data" discussed using a digital dataset from 2006 to 2013 for estimating the smoker prevalence in Brazil. Likewise, this can be likened to register use to estimate the number of smokers. Hence, the register can be used for the census process during health or national crisis (Bernal *et al.*, 2020).

"Count regression models for COVID-19" discussed the use was modelling, the count regression modelling model during the COVID-19 pandemic. The study was conducted in China, Denmark, Estonia, France, Germany, Italy, Malaysia, Philippines, Qatar, South Korea, Sri Lanka, Sweden, Taiwan, Thailand, UEA, UK, USA and Vietnam. The regression modelling method can be adapted to update the census during health and national crises (Chan *et al.*, 2020).

"Organisation & status of civil registration & vital statistics in the Arab countries" discussed the vital statistics and civil registration process in Arab countries (in Africa and Asia) such as Libya, Oman, Morocco, Qatar, and Sudan. The limitations of using civil registration and vital statistics, as discussed in this study, are missing data. However, the use of civil registration and vital statistics is still useful for census data collection during health or national crisis, but other data collection methods must be considered to complement this method (Statistics, 1988).

"Estimation and mitigation of epidemiology risk on a public transit route using automatic passenger count data" discussed the potential spread of infectious disease via passenger

encounters in the public transport system in Minneapolis. It was proposed that the algorithm procedure can be used to evaluate these encounters. Likewise, it is suggested to estimate the population during health or national crisis (Kumar *et al.*, 2021).

“Estimating weekly excess mortality at the sub-national level in Italy during COVID-19” discussed the use of modelled Spatio-temporal trends to estimate the mortality during the COVID-19 pandemic. The model provided a full probabilistic analysis of mortality during the pandemic. Hence, this model can also be adapted for census purposes (Blangiardo *et al.*, 2020).

"Feasibility of identifying families for genetic studies of birth defects using the National Health Interview Survey" discussed the use of already available NHIS to estimate the number of birth defects in the USA at that time. Likewise, a population-based register can also be used to estimate information about the census for a population (Wyszynski and Nolan, 2004).

"Community-based door to door (CDD) census of suspected people living with epilepsy: Empowering community drug distributors to improve the provision of care to rural communities in Cameroon" discussed the authors' use of the house-to-house census to distribute ivermectin in five communities in Cameroon. The authors got substantial results due to this intervention as the results found that CDD can be used to estimate epilepsy prevalence in many African countries. Likewise, a CDD can be likened to the traditional census. A traditional census can also be considered a means of monitoring the statistics of the population during and right after an epidemic, pandemic, health or national crisis (Kamgno *et al.*, 2020).

"Establishing a follow-up of the Swiss MONICA participants (1984-1993): record linkage with census and mortality data" discussed using record linkage procedures such as the Cox regression model, survival probabilities and Kaplan-Meier curves to assess the data in Switzerland. Likewise, this can be likened to using a register for census purposes when a traditional census cannot be conducted (Bopp *et al.*, 2010).

“Missing Data Approaches in eHealth Research: Simulation Study and a Tutorial for Non-mathematically Inclined Researchers” discussed the use of stimulation with multiple imputation techniques such as SPSS 11, MICE, NORM and Amelia to find missing data. These methods can be adopted for census purposes (Blankers, Koeter and Schippers, 2010).

“Life in lockdown: A telephone survey to investigate the impact of COVID-19 lockdown measures on the lives of older people” discussed the use of a telephonic survey to assess the impact of the pandemic measures. Therefore, the telephone survey can also be adopted for a

census (Brown Lesley, Rahena Mossabir, Nicola Harrison, Caroline Brundle, Jane Smith, 2021).





## **CHAPTER 4: RECOMMENDATIONS AND CONCLUSION**

The preceding chapter discusses the analysis, results and discussion of this study. This chapter discusses the study findings, relevance, limitations, recommendations and conclusion.

### **4.1 Study relevance**

The relevance of the study was that it gave answers to the aims and objectives of the study, which were to assess how the census was conducted during or right after health or national crises and how the results apply to us in our context (i.e., after the COVID-19 pandemic). The modalities of keeping a record of the population and housing statistics derived from this study are the use of CATI, CAWI, mail, email, fax, mixed methods and GIS, which have been proven to be effective in previous crises.

### **4.2 Study limitations**

The limitation of the study was that the study did not assess how countries with updated registers and vital statistics were able to maintain their record keeping in every state/province. Likewise, the study did not suggest ways of keeping updated registers/ vital statistics that will enable countries to keep records of the population dynamics during the crisis. Therefore, further studies are needed on how countries can keep abreast of their population and housing statistics throughout the year, even during health or national crises.

### **4.3 Study findings**

During pandemics, taking a census is still crucial, but safety precautions are being taken to prevent the spread of the disease and social contacts. The national statistics office does not usually have a contingency plan for a census during global emergencies. Hence, the experience of conducting a census during an epidemic, pandemic and national crisis such as COVID-19 is rare. UNFPA is not recommending changes in census modality for countries that have reached the advanced stage of their census planning. However, the census modalities can be changed if there is enough time to prepare and there are necessary preconditions for the new census modality. UNFPA advises countries to postpone their census process in areas hugely affected by the pandemic and continue the census preparations while trying to contain the pandemic (Carrasquell, 2020).

An online census will require widespread computer literacy, internet availability, national authority, building register, national address, and public acceptance, including the use of

CAWI, CATI and mixed methods. Mixed methods include combining different methods such as CATI, CAWI and updated registry or vital statistics. The use of mixed methods should be encouraged in different countries during the pandemic. A combination of registry-based census, online-based and traditional data collection processes should be encouraged.

However, the registry and online-based census will require pre-existing requirements and adequate planning that may not be available in some countries, especially in low-income countries (LMIC). Other methods that can also be explored to conduct a census after an epidemic, pandemic or national crisis include the French rolling census and population register. Rolling census and population register are more advanced statistical methodologies, which require substantial investment, testing, and capacity development both on the institutional and professional part of the Statistical Offices. Others are “palliative options” which can facilitate the field data collection through alternatives to the house-to-house interviewing, and then there are also some palliative options that would update available information or help generate estimates, which would temporarily cover the need for reasonable information to facilitate making adequate policy decisions.

#### **4.4 Conclusion**

The researcher concludes by suggesting two methods that can be used in place of the traditional census method during epidemics, pandemics and national and health crises. The methods include the French rolling census and keeping an accurate and updated population register. This method's significance, process, advantages and disadvantages are explained below.

##### **a. French rolling census as a means to palliate issues with the traditional census.**

The French census method has changed from the traditional census method (decennial) to a rolling census since 2004. This method has provided yearly statistics for the population for over fifteen years at the municipal, infra-municipal and household levels, and there have been several changes in the internet response mode, questionnaires and protocol. This method has been successful for the yearly census of 9 million persons. For about four to five weeks yearly census was conducted between mid-January to mid-February from 2004 to 2015. About 24000 enumerators were hired for the household and demographic survey process distributing paper questionnaires to every household all over the country. There is also a fine of 38euros for those that refuse to answer, which is referred to as a civil responsibility. The response rate as of 2019 was 96.1%; this was achieved through a strong campaign process before and after the census

period. The internet method of census collection was introduced in 2019, and there has been a high response rate of about 96% (Institut National de la Statistique et des Études Économiques, 2010).

The French rolling census can also be recommended as a palliative method instead of the traditional census. The French rolling census involves a continuous means of a cumulative survey covering the entire country for a long period. This is usually for several years instead of a short enumeration period or exact census date. Two parameters that affect the rolling census are the length of year of enumeration (linked to the update frequency required) and sampling rate (dependent on the geographic level required for the dissemination and the available budget). A sample framework can be used to produce a national result. The requirements for a rolling census are sampling practice, modelling techniques, good background and a technical point of view. A high-quality sampling basis is required to allow sampling in small areas such as villages and towns, and reliable extrapolations for the yearly file updates are crucial. Large and general consultations of major users and stakeholders such as the government and local and national administrations are also crucial (Roux, 2020).

The advantages of the French rolling census are the quick method of data updating and cost reduction as it is less expensive when compared to the traditional census method. The rolling census method is efficient because it provides detailed results, including the population of each municipality, age, sex, dwellings, industry etc. It is also possible to test new technologies, and there are possibilities for yearly process improvements. The disadvantage of using this process is that the data collected in the different parts might not be homogeneous due to the differences in enumeration times. Some characteristics of the rolling census are the provision of the households, dwellings and individual levels, universality and simultaneity (collection of data at different dates and adjustment to the same reference period) (Jean-Michel Durr, 2008).

**b. Population register/ civil registration as a means to palliate issues with the traditional census.**

Civil registration helps augment the population information from census and household surveys stating the population status and sizes. Civil registration aids population coverage, timeliness, access to a range of information, interoperability, shared metrics and legal simplification. Civil registration and vital statistics help population coverage since the population census may not cover sometimes excluding vulnerable populations. Although, civil registration may also have the issue of not achieving population coverage which can be due to geographic, cultural or economic reasons. However, the civil registration and vital statistics are a viable tool for keeping an update of the population dynamics as a continuous update of the civil registers will

provide more opportunities to get records of the unregistered citizens from the census. Evidence has shown that the birth, and death registration rate and the causes of death in most Latin American countries are rapidly increasing and seem virtually complete.

Civil registration will help ensure the updated ranges of information every year as suitable supplements for the household survey and census, which is useful for policymaking and planning. For example, it encourages the connectivity of a different range of information in the system, such as infant mortality, parents' identity, geographical location, socioeconomic status, and causes of mortality. The information can also aid public planning. Compared to the traditional census, civil registration will aid in providing timely information about a population. Civil registration is usually digitalised, which enhances quick information processing and is used to create a national profile and public decision-making.

Civil registration, through the process of interoperability with other databases, can provide information on the coverage and availability of an intervention/program, such as a family planning program or cancer awareness concerning different geographical zones in the country. This is to ensure proper planning and coverage increase. It can also the impact and significance of a program in a geographical area and how to increase future coverage. Civil registers are usually used to measure and compare common metrics in different countries. The sharing of metrics can also be used for evaluation and planning purposes; however, these purposes cannot be achieved if the measures are inconsistent. For example, common death cause classifications in different countries must be used to ensure proper evaluation and monitoring of the cause of death. The differences were used for comparability of different countries and used to set up health policies and other policies that will help reduce mortality and probably increase access to healthcare.

Some civil registration processes take a long process, and a legal simplification might reduce the chances of people's registration. For instance, in Peru, the process of live birth registration involves three different steps. However, reducing the steps might increase the desirability of the population in the registration. The desirability of the civil registration process is closely related to the simplification of the steps involved in civil registration. For instance, some Latin American countries, such as Peru and Brazil, have different organisations responsible for the civil registration and issuing of identity cards; simplifying the process to one organisation and step might increase the registration rate of the population.

Countries should be encouraged to adopt the use of online-based census and administrative registers for their census during and right after, as this will help reduce the risk of the reoccurrence of the health crisis in case of easily contagious disease. However, there is still a

need for a traditional census process that can be conducted at the end of the pandemic, epidemic and national or health crisis. The traditional census will help ensure the accuracy of the census and the updated population statistics. One of the disadvantages of civil registration is that the process can be boycotted, and this will not give accurate statistics for the population and houses in the country (Blayo *et al.*, 2004). Countries like Albania's population register has been boycotted since 1992; although they once had an accurate population register, this has had several demographic consequences (Blayo *et al.*, 2004).

In conclusion, this study suggests four main methods of conducting census during epidemics, pandemics, and national or health crises: adopting a population register, French rolling census, CAWI and CATI methods. This has proven to be effective in some countries such as France, Canada, and Australia and can also be adopted in several other countries. The implication is that the census will be conducted, and an update of the population statistics will be available at all times. Also, a communication campaign strategy for advertising census and significance must be efficiently adopted in countries (perhaps a social media campaign), the levy should be enforced for failure to participate in the census, and generally, the census must be seen as a civil responsibility.

### **c. GIS as a means to palliate issues with the housing census**

GIS and remote sensing can be used in place of housing census during a pandemic or crisis. Countries such as the UK, USA, South Africa, Tanzania, Japan, Australia, France, Uganda e.t.c have benefited from GIS and remote sensing for the census in the past. Census mapping systems that are linked to spatial elements such as buildings began in 1991-1993 (Japan) and 1995 (Israel) (Mokhele, 2011). The growth in GIS in the 1990s led to a surge in the use of digital geographic data. Although there is still a need for training and support of NSO to perfect this process, GIS and remote sensing can be adopted in place of the traditional housing census (Mokhele, 2011).

GIS and remote sensing are tools for traditional demarcation, mapping, new town development and planning as aerial photographs are used to pinpoint new residential areas and units. GIS technology was incorporated into the planning and pre-enumeration phase of the census in South Africa. The disadvantage of GIS is that household condition changes with space and time and it cannot be used for trend analysis since the geographic frame and administrative boundaries changes with time (Si Youcef *et al.*, 2021).

## 4.5 Recommendations

For future censuses, it is recommended that countries adopt the methods stated below as this will aid the record-keeping of various countries throughout the years, even in health or national crisis period. Although, the traditional census can also be conducted occasionally to ensure data collection accuracy. The use of a registry-based data collection tool for census purposes is essential. Countries like Austria, Bahrain, Denmark, Latvia, and the Netherlands have a well-developed civil register for their register-based census. These countries' census processes were not affected by the present COVID-19 pandemic, and this process will not be affected by future pandemics, epidemics or national crises. Thus, adopting a well-developed administrative register in other countries will reduce the effect of a pandemic, epidemic or national crisis on the census.

The UK 2011 census used methods like the form delivered by post and the completed form returned using online platforms. The central address register was a useful tool for the census form postage process, and all standard information was accessible online for free at the national statistics website (Economic & Social Research Council, 2011). A tailored campaign was used to reach out to them to encourage compliance and get age groups such as young adults, students, elderly ones (above 80) and some minority ethnic groups, unemployed and families with pre-schooled children to participate in the census (Economic & Social Research Council, 2011).

Generally, one of the ways by which households and populations can be estimated is by using administrative data. However, some of the challenges are the inability to produce updated information on the characteristics of the houses and population. The solution can be to include information to be collected in the usual administrative data and use information from other documents such as land, patients, work, or school census registers to complete the administrative registers to cover more information (JASON, 2016).

The USA were able to complete their census 2020 amid the COVID-19 pandemic using telephonic interview, mail, online and providing safety for the enumerators (Jarmin, 2021). This was also achieved by having 400,000 community and national partners responsible for sensitizing the people on the importance of census participation. There were staff who spent many hours collecting and processing the results in every part of the country. The census was also flexible, persistent and practical. Several data quality was also built into the data collection processes to ensure the data's accuracy (Jarmin, 2021).

However, the internet collection of data is highly dependent on trust in government and public perception to disclose their private information during the census (JASON, 2016). One of the



recommendations for the future of census taking is to increase the availability and collection of administrative data as this will constantly provide an update on the population dynamics. This will be followed by a traditional census to include the houses and persons that are missing from the government records. The digitalisation of administrative data and census results will also aid the data dissemination, availability and connectivity (JASON, 2016).

The use of improved software and technologies for data capturing and processing will help simplify the census processes, although the census operators must still deal with internet interruption, virus attacks and computer illiteracy issues. Bar-code technology can also be used to label an enumeration area with a specific barcode to avoid transcription errors and speed up census data processing. The shortfall of this is that it is only used by census staff that are inclined with this technology. Labelling the questionnaires with different codes based on their geopolitical zones will also aid the data-capturing processes. Automatic response on the census gadgets is to be avoided to ensure accurate capturing of the information, and this may require data entry personnel assistance to fill the census form (Dekker, 2001).

There are still plans for future technologies such as the use of fingerprints, facial identifiers, iris patterns or vocal prints to identify individuals and biometric identification of individuals. The use of multipurpose chipcard for the census, civil registration and other purposes such as library management, banking, medical services, and storage of personal information on digital platforms will enhance the census data accessibility. More innovations in census include digital mapping, electronic publishing, intelligent character recognition, use of the internet in the census and establishing accurate administrative data and civil registration. Although more technical awareness, methodological planning and time are needed for census planners.

The census committee must ensure that every country resident should be counted, especially the economically vulnerable persons. This is important for the government, business owners, or decision-makers planning purposes. A conceptual framework/ plan of having an accurate administrative register for different countries is needed to ensure the update of population information in years that traditional census cannot take place.

The COVID-19 pandemic disrupted the census in more than seventy countries, including Algeria, Barbados, and Mexico. Nevertheless, countries such as Canada, Australia and the USA were able to complete their census during the COVID-19 pandemic period, and countries like South Africa and Saudi Arabia are planning their census for 2022. Saudi Arabia plans to conduct its census fully on digital platforms, while South Africa plans to use the CATI, CAPI and CAWI methods for 2022 while taking all the COVID-19 pandemic measures. Fortunately,

lessons learnt from these countries can be used to plan censuses during epidemics, pandemics and national or health crises in other countries.

The Canada 2021 census achieved about 98 per cent response rate (84.1 per cent response rate just for the online questionnaires alone compared to 80 per cent response rate anticipated before the census). Although, some questionnaires were also returned with paper or completed through phone conversation (Statistics Canada, 2021). The 98% response rate was slightly lower than the 2016 response rate conducted through a traditional census. Completion of the question was a legal requirement as not completing the questionnaire would attract a fine of 500 dollars. This is compulsory for all residents and citizens in Canada (Statistics Canada, 2021).

The Australia 2021 census took place on the 10<sup>th</sup> of August 2021 and was conducted primarily online using the digital census service planned in late October 2019. The paper census forms were also sent to households on request. The census completion was compulsory for all citizens and residents of Australia as it was found that every one-dollar investment in the census would yield six dollars benefits in the economy of Australia. The response rate is still unknown since the results are still being processed. Saudi Arabia plans to conduct its census fully on digital platforms that will commence on the 9<sup>th</sup> of May 2022 (General Authority for Statistics, 2022). The methods include answering the questionnaire online and self-enumeration (Arab News, 2022).

Consequently, the best methods of counting the population that has been tried by other countries, such as keeping an updated civil register, French rolling census and modifying the traditional census with the use of internet, web, mail, fax and post, can be adopted. This will help every country prevent future disruption of censuses during national/health crises, epidemics or pandemics. Future studies are still recommended on various aspects, such as how to use algorithm procedure, multiple imputation techniques, probability analysis, fingerprints chips, and bank cards to keep an updated civil register are needed.



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