The Dissemination, Retrieval and Visualization of Spatio-Temporal Statistical Data through National Statistical Websites

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March, 2010

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By

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Thesis submitted to the International Institute for Geo-information Science and Earth Observation in partial fulfilment of the requirements for the degree of Master of Science in Geo-information Science and Earth Observation, Specialisation: Geoinformatics

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Abstract

A National Statistical Office (NSO) is a governmental organization with the main objective of collecting and disseminating statistical and spatio-temporal statistical data for the country. Currently, more than ninety percent of the world's NSO websites disseminate their spatio-temporal statistical data on the Web using tables, charts and static maps, thereby under-utilizing the functionalities offered by the Web for dissemination, retrieval and visualization of spatio-temporal data. The focus of this research was to contribute to the improvement of the dissemination, retrieval and visualization of spatio-temporal statistical data through national statistical websites from the users' perspective.

An investigation was carried out on all NSO websites to determine methods in which spatio-temporal statistical data are currently being disseminated, retrieved and visualized on these NSO websites and an inventory was developed. Applying a user centered design approach, a requirement analysis testing was also conducted to determine the users' needs relating to the retrieval and visualization of spatio-temporal statistical data, and an improved prototype of a part of the Nigerian NSO website was developed. The prototype was developed based on the inventory and the output of the requirement analysis testing. The prototype was finally tested for effectiveness, efficiency and users satisfaction, from the users' perspective.

From the requirement analysis conducted, using think aloud, questionnaire and interview techniques, and the Nigerian and Swedish NSO websites as case studies, it was observed that the methods of dissemination, retrieval and visualization currently available on most NSO websites do not satisfy users' needs. The prototype evaluation shows that animated and interactive maps are effective for the dissemination, retrieval and visualization of spatio-temporal statistical data, and that the use of the proper cartographic variables on maps are also important for the proper dissemination of spatio-temporal data from users' perspective.

Keywords
Dissemination, retrieval, visualization, animated proportional symbol map, interactive choropleth map, national statistical websites and spatio-temporal.

Acknowledgements

All glory be to God for his grace, strength and favour that has seen me through the whole period of my study and research.

My heart of gratitude goes to Dr. Van Elzakker for his advice and supervision made this work a reality. I also appreciate Kobben B. MSc, for all his supports and advice through the research phase. Their combined experience and supervision made this research a possibility.

I specially want to thank Feringa Wim, for all his help and support during the prototype development phase of my research. To all the lecturers in ITC, who has impacted in me all that I have learnt, both during the lectures and research, I am really grateful.

My sincere gratitude goes to my parents, sisters and entire family for their love supports and prayers throughout my study in the Netherlands.

I specially want to appreciate my family here in the Netherlands, the entire member of the R.C.C.G Amazing Grace Sanctuary for their encouragement both in words and prayers. Also, to Pastor and Pastor (Mrs.) Awede, Pastor and Deaconess Adelesi. I am truly grateful.

I want to appreciate my classmates GFM 2009/2010, especially Shelton, Habtom, Rosita, Long and Maia for their supports and help through my research. Thank you so much.

Finally, to Anietie, thank you so much for your supports, prayers and encouragement and for believing so much in me, to Uduak and Femi, thank you for being sisters away from home. Thank you so much and I love you all.

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List of acronyms

MSM	Multiple Static Map
NBS	National Bureau of Statistics
NSO	National Statistical Offices
PDF	Portable Document Format
SSM	Single Static Map
TP	Test Participant
UCD	User Centered Design
URL	Uniform Resource Locator
WWW	World Wide Web
XML	Extensible Markup Language

1. Motivation and Problem Statement

1.1. Overview

A National Statistical Office (NSO) is a governmental organization that has the duty of the collection and dissemination of statistical/census data for the country as a whole. These data are either collected through census programmes, as most countries do, or by establishing other ways of collecting these data, for example, through municipalities (in the Netherlands, for instance), or through sampling. A census is the process of collecting information on the official count of the human population of a specific administrative area of interest (Redido-Cusi, 2002). The process is also used for officially counting and gathering of socio-economic and demographic data such as: population of different categories, agriculture, birth rate, death rate e.t.c of a place at a certain time and these data are collected at different levels, such as provincial, regional and national. These data are of great importance in the planning and decision making of a country and they are presented to users in various forms such as: tables, charts or diagrams. Various disciplines in time past have used maps for dissemination of their data, and also statistical offices are coming to see the importance of using maps for data dissemination to the users. Maps are graphical representations of data using signs and symbols. They are used to visualize geospatial data, and they help users to better understand geospatial relationships between objects. Maps are easier to understand and give the overview information about the data (for example; Where are most people living in a country?)

According to Kraak (2006), the International Cartographic Association defines a map as a symbolized representation of a geographical reality, representing selected features and characteristics, resulting from the creative effort of its author's execution of choices and is designed for use when spatial relationships are of primary relevance. The traditional paper map has always allowed for a 2D static representation of information for a particular moment in time on the map, but a map popularly known as "The Minard map" (by Charles Joseph Minard; from 1869; showing Napoleon's campaign from 1812-1813), is an illustration of the use of a map with a temporal component as well. Tufte (URL1), in his statement "a narrative graphic of time and space which illustrates how multivariate complexity can be subtly integrated in a map", expresses how temporal properties can be mapped. Maps as a form of communication have benefitted dramatically as a result of the WWW since the early 1990s and presently; millions of maps are being distributed to Internet users on a daily basis. Improved technologies have made web usage easier and more effective for the dissemination of spatially related data on the web (Marchionini, 2002). For several years, the WWW, a subset and the graphical part of the Internet, has become a medium to acquire and disseminate geospatial data and has been used for publishing maps. Although the basic set-up allows for only publication of static maps with very limited interactivity, it can be expanded by additional server-side applications or client-side plugins (Kobben, 2001).

The Internet has clearly become the new medium for cartography. Web maps have some characteristics that differentiate them from other forms of on-screen maps. One of the characteristics is the ability to

view the maps either from the users or producers point of view and maps can be made by different users for different purposes on the WWW. Maps are used as interfaces, as links to other information, search engines and also as an output for the result of a query. For most NSO websites, maps are used only as graphical or pictorial representation of statistical data using cartographic variables and are means for the visualization of these data, although they could be used for the purposes stated above.

1.2. Problem Statement

Until recently, statistical data were disseminated through the use of papers, textual or tabular forms. For some years, data were also made available in digital format on diskette or CD-ROM (Van Elzakker et al., 2003) and this could be because most NSOs focus more on the dissemination of statistical data and not how users actually visualize these data.

In a research carried out by Redido-Cusi (2002), a world-wide overview of existing NSOs that disseminate their data through the web was created and analyzed to determine how census data were disseminated by these NSO websites. A switchboard of all the NSO websites was created in this research. The research showed the various methods in which statistical data were disseminated by the NSOs. Furthermore, the NSO website of the Philippines, along with five other websites (India, Israel, Sweden, Switzerland, Canada, Netherlands, UK and USA), were critically analyzed by the researcher, to determine their activities and services on the web, how their statistical data were disseminated, and then the outputs were used to develop a prototype of a Philippines' NSO website.

Another research by Van Elzakker et al., (2007), gives an update on the inventory of NSO websites on the web. It shows that more of the NSOs now apply knowledge of static maps and very few with interactive maps for the dissemination of their statistical data, although these maps are restricted to just mapping the attributes of the data. The research, using the StatLine database of Statistics Netherlands as case study, looked closely at improving ways of retrieval and dissemination of statistical data on the web and also other functions of maps on the web, such as using web maps as interfaces, for online analysis and exploration etc. It was observed that NSOs are one of the many organisations that are become more aware of their roles in providing mapping services, which varies from planning purposes, decision making to academic and research purposes and the general public at large, to their various users.

Now, there is more awareness of the possibilities and advantages, i.e. accessibility and actuality (Van Elzakker et al., 2007), offered by the web and these have led to even more NSOs having their data and maps published on the web, although by looking at some NSO websites such as Kenya, Malta, Sri Lanka, it was observed that most of the maps are still only in PDF format or static map images. For example, the Nigerian NSO only has it statistical data displayed textually in MS Word and PDF format along with a few charts. Meanwhile, some other countries disseminate their data using interactive maps, for example, United Kingdom, Netherlands, Canada, but these maps only focus on the geographic and attribute characteristics of the data, but not mapping the temporal component of statistical data, making it impossible to see dynamic changes or trends. For most NSO websites, it is possible to access and download temporal data, in table and chart formats; but only a very limited number of NSO websites publish maps on their websites and, when available, the maps do not easily reflect the temporal changes

of these data. This, therefore, makes it impossible for users to visualize the trends of these temporal changes. As such, the retrieval, dissemination and visualization methods that can be found on the NSO websites currently, do not always fulfil all the users' needs in the analysis and visualization of trends and patterns that could be obtained from temporal statistical data (Nivala et al 2008).

Therefore, there is a need to consider an effective and efficient way of dissemination, retrieval and visualization of spatio-temporal data on NSO websites. This research will be focusing on how best to disseminate, retrieve and visualize spatio-temporal statistical data on NSO websites, while basically taking into consideration the needs of users of these spatio-temporal statistical data.

1.3. Motivation

It was not surprising that some 7 years ago, spatio-temporal data were displayed as text, tables and static-view maps (e.g. in PDF format), which could be retrieved and disseminated fast but cannot, like paper maps, be adjusted to the individual needs of users (Kraak et al., 2001). According to Van Elzakker et al., (2007), still in 2005, only 19% of the 184 NSO websites on the web, allowed individualized output in the form of thematic or interactive cartographic visualization. This hindered the usability and possibilities that could be obtained from the use of statistical data and most importantly, spatio-temporal statistical data. In many cases, the users like to interact with these data in order to derive more information than provided by NSOs. For example; Which province has the largest growing unemployment rate? Where do I establish my new business? The web offers more opportunities than are being utilized by NSOs. It is a suitable and convenient platform to display dynamic processes or information and can also facilitate the possibility of mapping the temporal component of spatio-temporal data. The web not only offers easy accessibility and actuality of maps (van Elzakker et al., 2007), but also provides different map tools and map-related services (Nivala et al., 2008), which can be used for retrieval and visualization of temporal statistical data by users.

Technological developments of the web have provided improved tools and techniques for designing interfaces and interaction with the websites (Nivala et al., 2008). This has also encouraged other forms of map display that could easily be modified by users when needed. For example;- the use of interactive and animated maps. The use of animated maps helps to improve our understanding of spatial and temporal information (Blok et al., 2008). According to Rae (2009), " It remains true that the vast riches of national census data tables for migration and commuting (not to mention other datasets relating to business relocation or civil aviation), are largely locked away from view" . Rae expresses regret on how a vast amount of information remains hidden from the users' view for lack of proper viewing tools in time past. He also commented on the opportunities offered by modern technology of geovisualization; " Put simply, it is now possible to produce at-a-glance dynamic geovisualization that begin to unlock the potential of datasets traditionally closed to public view" (Rae, 2009).

Finally, although there are lots of opportunities offered by the development of the web for retrieval, dissemination and visualization of temporal statistical data, analyzing the need of users of statistical and spatio-temporal statistical data is very crucial for designing an effective and efficient NSO website. In order to determine the current ways of dissemination of data by the NSO websites on the web, there is the need to update the inventory of Redido-Cusi (2002) and evaluate the current state of existing

NSO websites, the cartographic functionalities and the format of dissemination and retrieval of data of these websites. In doing this, specific attention will be paid to the retrieval, dissemination and visualization of spatio-temporal statistical data, which were not yet considered by Redido-Cusi.

For this research, a prototype will be developed for an improved NSO website for Nigeria. This is because the Nigerian NSO website is one of the 18 newly added website from the last update. The Nigerian NSO website was observed to disseminate its statistical and spatio-temporal statistical data using textual format, tables and charts. The NSO does not provide any form of map and data can only be retrieved in PDF file. The researcher is also a Nationality of Nigeria; therefore, this research is a contribution to the NSO website of the researcher's country.

1.4. Research Objectives

The primary objective of this research is to contribute to the improvement of the dissemination, retrieval and visualization of spatio-temporal statistical data through national statistical websites from the users' perspective.

This primary objective is divided into four sub-objectives:

1. To give an overview of methods in which spatio-temporal statistical data are disseminated currently on NSO websites world wide.
2. To analyze the needs of the users of temporal regional statistical data.
3. To propose the cartographic functionalities and the format of dissemination and retrieval of the temporal data on NSO websites.
4. To develop a prototype of an improved NSO-website for Nigeria with cartographic functionalities to meet the users needs, with specific attention for the retrieval and dissemination of spatio-temporal data.

1.5. Research Questions

To achieve these objectives, the following questions arise:

- How effective are the existing functionalities and methods in satisfying the users' needs?
- What are the needs of the user in relation to temporal regional statistical data and their visualization through map displays?
- What are the factors to be considered for the dissemination of temporal regional statistical data from the users' perspective?
- How useful are the NSO websites for the dissemination, retrieval and visualization of temporal statistical data currently?
- What technologies are used for displaying the temporal component of the statistical data on existing statistical websites?
- What are the cartographic functionalities for effective and efficient dissemination of the temporal component of statistical data through the NSO websites?
- How should these functionalities be implemented in the prototype design?
- How effective is the new prototype in satisfying the users' needs?

- How efficient is the designed prototype for the dissemination and retrieval of spatio-temporal data?

1.6. Methodology

The method adopted for this research is the User Centered Design (UCD) approach. This is an approach that supports the entire development process of user-centered activities, in order to create applications which are easy to use and are of added value to the intended users(Van Elzakker et al 2008) . UCD represents the techniques, processes, methods and procedures for designing usable products and systems, but most importantly, it is the philosophy that places the user at the centre of the process (Rubin et al 2008). This approach involves the evaluation of the products / prototypes with real users or intended users of these products / prototypes at the following three production phases. The UCD approach is an iterative process that starts with the *requirement analysis phase*, i.e. analyzing the users' needs of the product in terms their context of use and tasks**,** to the *produce design solution phase*, involving building or developing prototypes, then back to the users at the *evaluate design phase* (see Figure 1-1 below).

According to Scholtz (2004), usability research can be classified into two types of evaluation namely, formative evaluation and summative evaluation (also known as usability evaluation).

Formative evaluation is the process used for obtaining user feedbacks for early concepts or designs of any product (Scholtz, 2004). The major aim of formative evaluation is to collect information that would aid the developer in the design of the product. For this method of evaluation, no product or prototype exists.

Usability (or summative) evaluation is a part of usability engineering, which is a discipline that provides structured methods for achieving usability in user interface design (Scholtz, 2004). The purpose of carrying out a usability evaluation of an existing product or prototype would be to find out if the product or prototype actually satisfies the goals specified in the ISO definition (Van Elzakker, 2009) i.e. is it effective, efficient and satisfactory from the users' point of view. Usability evaluation is also used to answer users' questions concerning a system.

1.6.1. Pros and Cons of Evaluation Using the UCD Approach

According to (Barnum, 2002; Dumas et al, 1999; Hertzum, 1998; Nivala et al , 2008; Scholtz, 2004), advantages of usability evaluation using the UCD approach can be observed from three major points of view namely: Users, Developers and Managers. The advantages include developing an effective, efficient and satisfactory system from the users' perspective. It reduces the time invested in developing a better system that meets the users' requirements. The UCD evaluation approach ensures that less cost is invested in the development of the system, thereby increasing productivity and profit gain. Finally, evaluation, based on actual observation of the users' interaction with the product, helps for easy identification of problems and measure how well the product performs against stated goals. As expected, there are a few disadvantages of using the UCD evaluation approach, such as: it is time and money consuming to plan and execute the usability testing, difficulties in finding suitable and willing participants.

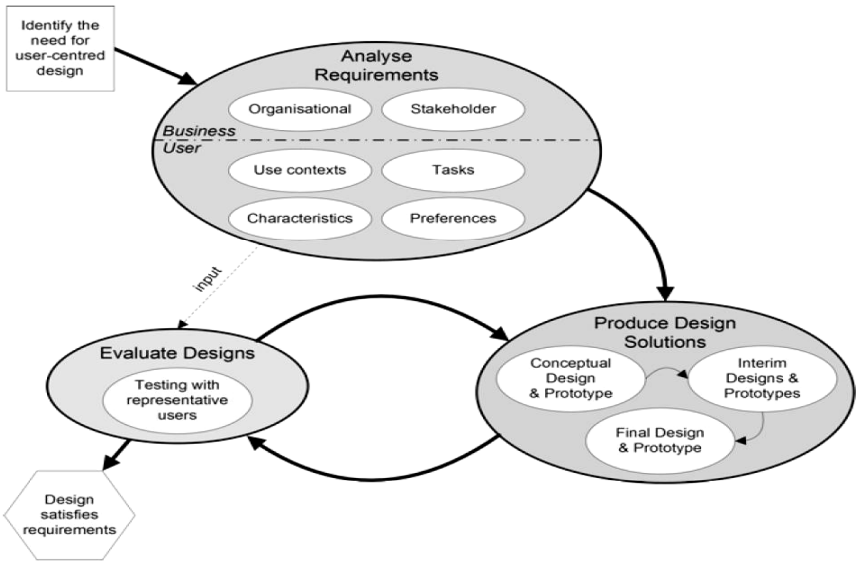


Figure 1-1: User-Centered Design (UCD) Approach Source: (van Elzakker & Wealands, 2007)

1.6.2. Requirement Analysis Phase

Requirement analysis is the first and important stage of a user-centered project. It is the phase where the basic requirements are determined and the problems encountered by users are also discovered. Sometimes, additional functionalities are included into the product and sometimes new organizations intend developing a similarly existing product (Dumas et al 1999). For the stated reasons, usability evaluation of existing systems is of great importance at the requirement phase of the development, for the product to meet the needs of its expected users. In this research, the products that would be evaluated in the requirement analysis testing by test participants are the Nigerian and Swedish NSO websites, although prior to this testing session, an investigation on all existing NSO websites will be conducted by the researcher in order to determine the various methods in which spatio-temporal statistical data are disseminated by NSO websites world wide.

1.6.3. Prototype Design Solution Phase

This phase will be the prototype developing phase. It will involve developing a prototype of a part of the Nigerian NSO website, and will focus more on the dissemination, retrieval and visualization of spatio-temporal statistical data. Adobe Flash CS4 Professional will be used for the prototype development. This software offers the possibility of creating highly interactive maps on the web with lots of functionalities while taking into consideration the speed of the Internet connection, size and format of the data. Data obtained from the requirement analysis phase and the results of the evaluation of the existing NSO websites, will be used to develop a more user friendly Nigerian NSO website, as far as the dissemination, retrieval and visualization of spatio-temporal statistical data is concerned. This

prototype will focus only on the functionalities and methods of dissemination, retrieval and visualization of spatio-temporal population data and the data will be stored in a simple format effective for testing the prototype.

1.6.4. Evaluate Design Phase

The evaluation design phase is another UCD stage which will involve the use of test participants. This is to determine the effectiveness and efficiency of the new prototype for the dissemination, retrieval and visualization of spatio-temporal statistical data against the currently existing methods on the Nigerian NSO website. For this stage, a combination of the think aloud, questionnaire and interview techniques will used for data gathering. The test participants will be given the prototype and will be required to carry out tasks and scenarios similar to those that were performed at the requirement analysis phase, while thinking aloud. They will also be expected to fill the questionnaires before and during the task execution. A brief interview will be conducted after the tasks execution to determine users' satisfaction. The tasks will be timed in order to determine the efficiency of the prototype. This will allow for the possibility of evaluating the effectiveness of the developed prototype to the currently existing NSO website.

1.7. Conclusion

The first chapter of this research provides the general orientation of the research. It defines the concepts, research aim and objectives, research problems, research questions and the research approach and methods. It also describes what UCD is, what usability evaluation is and the advantages and disadvantages of usability evaluations and the different types of techniques of usability evaluation. The next chapter contains detailed information about the update of the inventory of NSO websites originally made by Redido-Cusi (2002), with their modes of dissemination and retrieval of statistical data. More importantly, information is added to the inventory about the dissemination, retrieval and visualization methods of spatio-temporal statistical data on existing NSO websites. Finally, chapter 2 contains a literature review of what has been done in the field of geovisualization of spatio-temporal data. The third chapter involves describing the processes of selection of test participants, setting up the test environment for the requirement analysis phase of this UCD project, defining the scenarios and tasks, and conducting usability testing. A section also deals with analyzing the data obtained from the usability test and defining what are the users' requirements relating to the dissemination and retrieval of temporal data from the Swedish and Nigerian NSO websites. The next chapter includes how the results obtained from the test are used to develop the prototype of part of the Nigerian NSO website and what functionalities are added to the prototype for the dissemination, retrieval and visualization of spatio-temporal statistical data on the web. Another chapter is dedicated to the evaluation of the prototype designed, in order to determine the effectiveness, efficiency and users' satisfaction of the functionalities for dissemination, retrieval and visualization of spatio-temporal statistical data included in the prototype. The last chapter includes a summary of how the research objectives have been achieved, the problems encountered during the research and recommendations to future related researches will be proposed.

2. Review of dissemination of Spatio-Temporal Statistical data on NSO websites

2.1. Overview

This chapter is subdivided into two parts. The first part will report on the updating of the NSO inventory and NSO switchboard originally created by Redido-Cusi (2002),in order to determine the changes that have occurred on the NSO websites between 2002 and 2009, while most importantly, focusing on the methods in which spatio-temporal statistical data are disseminated by NSO websites. The second part of this chapter is a literature review of the different methods in which spatio-temporal data are generally disseminated and visualized on the web (i.e. not only through NSO websites), while keeping in mind the various ways in which these data are stored in the databases to achieve the best output.

2.2. Introduction

As defined in chapter one, a National Statistical Office (NSO) is a governmental organization that has the duty of the collection and dissemination of statistical/census data for the country as a whole. These data are mostly collected through census programmes, organised at certain intervals mostly, five to ten years interval or by establishing other ways of collecting these data, for example, through municipalities registration (in the Netherlands), or through sampling. A census is the process of collecting information on the official count of the human population of a specific administrative area of interest (Redido-Cusi, 2002). The process is also used for officially counting and gathering of socio-economic and demographic data such as: population of different categories, agriculture, birth rate, death rate e.t.c of a place at a certain time and these data are collected at different levels, such as province, regional and national. Before the Internet, census data were disseminated to users in analogue and digital formats, such as paper files and CD ROMs. Most of these data were disseminated through the use of tables either in word format or as excel files. The use of charts such as: pie charts, bar charts, histograms and graphs were also adopted as an alternative means of visualization of statistical data most especially, temporal statistical data.

However, since the establishment of the WWW, most NSOs now disseminate their data through the web. Although it is interesting to know that NSOs with their statistical data on the web, still adopt the traditional approaches of data dissemination such as: tables, charts, or static maps as a means of dissemination of data on these websites. In the early 2000 (Redido-Cusi, 2002), it was observed that very few of these NSO websites use presentation maps as a means of dissemination of statistical data and these maps were strictly images in PDF formats. There was hardly any form of interactive maps on these NSO websites. In 2005, there was an update on the switchboard of the NSO websites and it was observed that regional statistical data collected by NSO are made more available to users through the web (Van Elzakker et al 2007) Also, more websites provided the possibilities of online individualized output (i.e. 17% in 2003 to 23% in 2005) and 19 websites in 2005 as compared to 6 websites in 2003 had any form of interactive cartographic visualization on their websites. Currently, in the analysis carried out in this research on the existing NSO websites, more NSO websites now feature maps on

their websites, although these websites still restrict themselves to the use of images and very few of them have interactive maps with little functionality such as: the zooming functions, panning and layer selection functions. Another important role of maps on these NSO websites is that they serve as geographical interfaces for dissemination of statistical data. Some of the maps presented on NSO websites are clickable or mouse over maps that serve as interface to statistical data embedded in them. An example of a geographical interface map is the NSO switchboard (URL3)

2.3. The National Statistical Offices Switchboard

The NSO switchboard is an interface created to serve as a link to all NSO websites, whose countries are officially recognized by the UN and publish their statistical data on the web. It also provides additional information on some functionalities and opportunities offered by these NSO websites in the dissemination and retrieval of their statistical data. The switchboard also provides a good and solid platform for the analysis of the various visualization methods applied by the NSO websites for the dissemination of their spatio-temporal census data.

In order to determine how both statistical and spatio-temporal statistical data are being disseminated by NSO websites world wide and to effectively update the existing switchboard with the results of our findings, a thorough analysis was made on all the NSO websites to determine the current applications existing for dissemination of statistical data on the NSO websites. This result will be used to update the existing inventory. To carry out this part of the research, the investigation, analysis and update process was divided into four sections namely: National Statistical Offices on the web, Description of statistical data functionalities on the NSO websites, Description of spatio-temporal statistical data functionalities on the NSO websites and Update the NSO switchboard.

2.3.1. National Statistical Offices on the Web

The first step to updating the switchboard was to search the web for all UN recognized countries whose NSOs currently disseminating their statistical data through the web. This was done by updating the spreadsheet created by Redido-Cusi (2002). Using the following websites, National Statistical offices and the world wide web, also referred to as the switchboard in this research (URL3),United nations statistics division (UNdata) (URL4), the U.S census bureau (URL5), Economics departments, institutes and research centres in the world (EDIRC) (URL6) and statistics Norway (URL7),a list of all NSOs which currently publishes statistical data on the web as created. This provided a comprehensive way to finding all NSO websites currently existing on the web and their web links. See appendix 1.

2.3.2. Description of Statistical Data Functionalities on NSO Websites

Redido-Cusi (2002) analyzed the in-built functionalities, complexity in accessing the database of NSO websites and the use of maps and other methods, through which census data are disseminated by these websites. For this research, the same columns and criteria along with the definitions of each column, (see Table 2-1 below), were used for investigating and updating the functionalities and possibilities available on each website for dissemination and retrieval of census data.

Language	This gives the indication of the languages used for communication purposes on the NSO websites and they are divided into three types: the official national language, English language and/or any other language(s).
Keyword search	This indicates whether a keyword search mechanism is provided or not. If the website provides a keyword search mechanism, information may be found more easily.
Census data retrieval format	Data may be presented to users in different formats: textual, tabular, chart and map.
Data download capability	Websites with this functionality allow users to download data (be it text, tables, charts or maps) in a digital format that can be imported or interpreted directly by available software (e.g., a spreadsheet or GIS package).
Census data retrieval cost	In many countries, census and other national statistical data are considered public property and may, therefore, be obtained free of charge. In other countries, registration (or subscription) may be required, or other methods of payment are applied to cover some costs of infrastructure and/or dissemination (e.g., the costs of acquiring statistical reports on paper).
Aggregation Level	This shows which administrative levels the NSO is disseminating its data through the WWW. It could be National level and/or the different lower levels (e.g provinces, districts, municipalities).
Individualized output of census data	Most websites supply the data in preconceived ways, be it in textual, tabular, chart or map format (see 'Census data retrieval format' above). But some websites allow users to individually prepare the desired data output on-line. Tailor-made tables, charts and thematic maps are possible types of individualized output in static form. The interactivity function identifies the possibility for the user to interactively adjust the current static way of representation (e.g., changing the legend of a thematic map display).
Geographical or map interface for census data retrieval	This functionality refers to the availability of a map interface to define the geographical extent of the required data (e.g., by clicking on the area of interest or by specifying a bounding rectangle).

Table 2-1: Components of the NSO inventory as defined by van Elzakker et al (2003)

Below are the outputs of the investigation carried out on the switchboard of the NSOs, to determine the current ways in which statistical data are disseminated on NSO websites.

- **Language** – From analysis, in 2002, 66% of the NSO websites disseminate their statistical data using their official languages, 79% uses English and 19% other languages. Currently, 69% uses their official languages, 82% uses English and 22% uses other languages. Many countries have adapted the use of other language apart from their official languages but most websites still combine there official language with the use of the English language.

- **Keyword search** – This allows for easy location of information on the website. Initially, only 55% of the websites offered. Currently, 68 % of the NSO websites offers this functionality. On some websites, for example, the Azerbaijan NSO website, a theme list is provided to allow for easy navigation to the required information as well.

- **Census data retrieval format** – 82% of the websites uses the textual format to disseminate census data on their websites by quoting figures in text written reports and these are either in PDF or MS Word document formats. 98%, of the websites disseminate their data using tables and Excel spreadsheets for the dissemination and retrieval purposes. The use of charts is another way in which census data are disseminated and could be visualized on NSO websites. These include the use of graphs, bar charts, pie charts and histograms and 74% of the NSO websites use this method. 43.4% of the websites are observed to use maps for dissemination of statistical data along with the other methods mentioned earlier, although most of the maps are either as PDF outputs or just images. From this statistic obtained, there has been no significant change in the numbers of NSO websites that disseminate their census data using maps when compared to the statistics obtained in Van Elzakker et al (2007), where 50% of the websites used maps for dissemination of statistical data. It was also observed that although there are 18 new NSO websites compared to the inventory update in 2005, none of these new NSO websites disseminate their data using maps.

- **Data download capability** – This function is currently provided by 48% of the NSO websites, and this is an increase from the initial 43.5% of the websites in 2002. Websites with this functionality allow users to download and save data (mostly as tables) in a digital format such as XLS, CSV, DBF so that it can be imported or interpreted directly by available software (e.g. a spreadsheet or GIS package).This allows for users to interact or modify the statistical data to produce personalized outputs or use with other forms of visualization methods other than those provided by the NSOs. In most cases, users also have the option to print the required census data.

- **Census data retrieval cost** - In most countries, census data are considered public property, since they are acquired using income taxes and therefore are made available to the users free of any cost. In 14 countries, for example, South Africa and Sweden, registration (or subscription) is required before users can access the data, while for 56 (30.4%) countries, for example, Ukraine, Venezuela, Finland and Spain, other methods of payment are applied to cover some costs of infrastructure and/or dissemination of these data.

- **Level of Aggregation** - These show the various administrative levels in which the statistical data are collected and disseminated by various NSOs through their websites. This level of aggregation was subdivided into four levels: 1st level-National, while the 2nd level, 3rd level and 4th level could a representation of district, county, state, local government area etc, depending on the administrative units of each country. 84.2% of the NSO websites collect and disseminate their census data on two or more aggregate levels while 15.7% disseminates only at the national level. From the latter it is not possible to derive information about geographical differences within the country. This shows an increase of 7% in the number of NSO website that disseminate their statistical data at the national level alone, from the analysis carried out in 2002.
- **Individualized output of census data** – Most websites supply the data in preconceived ways, be it in textual, tabular, chart or map format (see ‘Census data retrieval format’ above), but a total of 25% (46) of the websites allow higher interaction between users and data, thereby

creating the possibilities for users to individually prepare the desired data output on-line. Tailor-made tables, charts and thematic maps are possible types of individualized output in static form. The interactive functionalities observed on the NSO websites allow for the possibilities of users to interactively adjust the current static way of dissemination and visualization of the map output, for example, changing the legend of a thematic map display, zooming functions, etc. It is interesting to know that 40 of these 46 websites allow for users to select the types and years of data required (as shown in Figure 2-1) and generate a table outputs, while 8% (15) of the websites, for example, Australia and Andorra websites, allow any form of interactive output such as, interactive charts for example, the Brazilian website (see Figure 2-11).

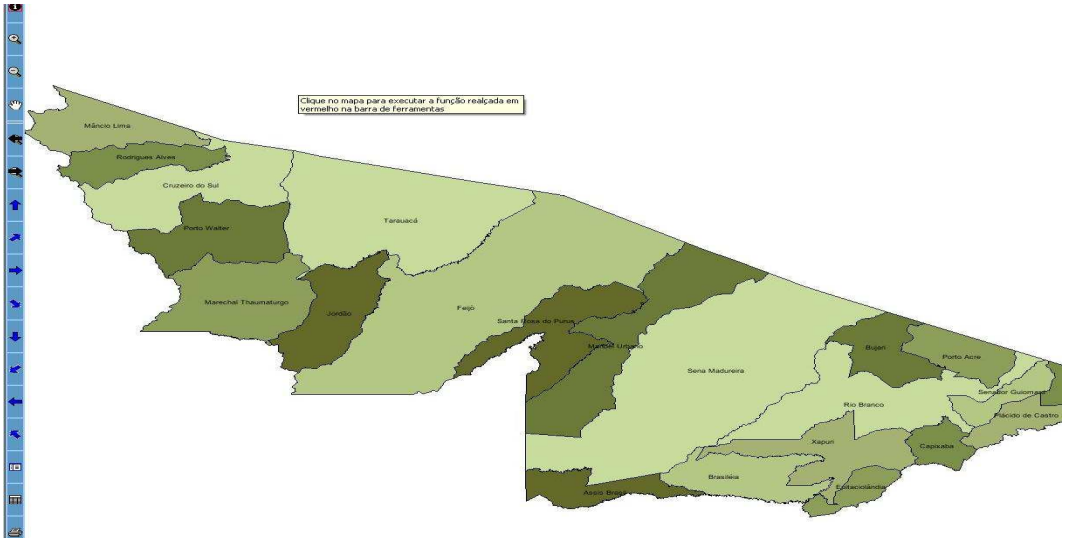


Figure 2-1: An individualized population map of Brazil (URL15)

- **Geographical or map interface for census data retrieval** - About 26% of the NSOs offer this functionality on their website and an example of such is Chile. Since 2005 update, there has been no change in the number of NSO websites offering this functionality to users. The map of Chile displayed in Figure 2-2 below, serves as an interface for the retrieval of statistical data on this website. This simply means that it is possible to retrieve the statistical data of a particular location by clicking on the required location in the map and have the data displayed in the oval as seen on the map.

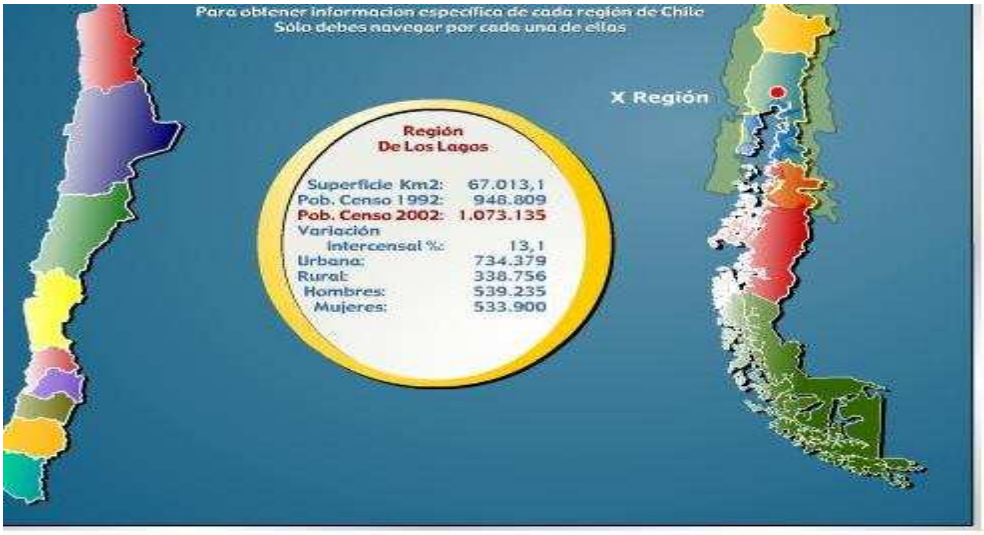


Figure 2-2: A geographical or map interface of Chile with the population data displayed in the oval at the centre of the image (URL14)

2.3.3. Spatio-Temporal Statistical Data Functionalities on NSO Websites

Statistical data are in some case spatio-temporal data. This represents a collection of statistical data of a particular location, region or country over a period of time. Like other spatio-temporal data, they have three major characteristics; **what** (object) a geographical phenomenon is; **where** (location) and **when** (at what time). For proper study of any geographic phenomenon, the process begins with the acquisition of the data, then exploration and analysis, and finally visualization of data in order to understand the spatial relationship pattern or trend of the data. The focus of this research is limited to the dissemination, retrieval and visualization of these data through NSO websites.

As stated by Jeong et al., (2006), "one of the major challenges users face when working with spatio-temporal data is a lack of useful and effective data visualization tools and techniques for the analysis of multi-dimensional spatio-temporal data to have better understanding of the quality and characteristics of the data". Rae (2009) went further to say that, "it remains true that the vast riches of national census data tables for migration and commuting (not to mention other datasets relating to business relocation or civil aviation),are largely locked away from view". This expresses regret on how a vast amount of information remains hidden because of lack of proper viewing tools in time past and while going a step further, he commented on the opportunities offered by the modern technology of geovisualization, "Put simply, it is now possible to produce at-a-glance dynamic geovisualization that begins to unlock the potential of datasets traditionally closed to public view".

Another research by Griffin et al., (2006), while limiting to maps as the method for dissemination of spatio-temporal data, made comparisons to the effectiveness of the use of animated maps over static small multiple maps for visualization of spatio-temporal data. The focus of the research was to compare the effectiveness of animated maps to the static maps based on the map readers' ability to identify clusters that move over time and through time. The result obtained from this research shows that map readers were able to complete their tasks more quickly and effectively, while at the same time were able to identify more patterns correctly with animated maps than with the use of small-multiple static maps.

Animation is defined as a rapid display of a sequence of images of 2-D or 3-D artwork or model positions in order to create an illusion of movement (URL19). Animations can be divided into two types, namely: temporal and non-temporal animations. Temporal animations are animations that show changes over time. This animation shows changes through maps as time-lapses while non temporal animations are animations that show changes of different scenes. In differentiating between temporal and non temporal animations, Dransch (1995) defines temporal animated objects as geo-objects that changes relative with time while for non temporal animation, the changes occur relative to factors. The basic difference between both animations is that for the temporal animation, each frame shows individual time moment, whereas the non temporal animation shows individual aspect.

Currently, majority of the NSO websites disseminate their spatio-temporal statistical data using tables, charts, and static maps. On some NSO websites, multiple static maps are used for dissemination of data of different years, while in some cases the single static maps are used. Although lots of researches carried out in the past proposed the use of animations for dissemination of spatio-temporal data, however, most data suppliers such as the NSOs do not provide these services on their websites. Below are the various methods in which spatio-temporal statistical data are and maybe disseminated on the NSO websites.

The spatio-temporal statistical data functionalities on NSO websites, is the main area of focus for this study. This section focuses on an investigation of the dissemination and retrieval of spatio-temporal statistical data on NSO websites. This investigation has not been done before in a systematic way. The aim of this inventory was to determine the various methods by which spatio-temporal data are disseminated, retrieved and visualized on NSO websites and by combining this output with a usability evaluation of some selected NSO websites, in order to come up with a better solution for dissemination and retrieval of spatio-temporal census data on NSO websites.

To effectively carryout this research, an additional section, called temporal data was added to the original table of existing functionalities and possibilities of the NSO Switchboard. The temporal section was subdivided into seven columns along with their definitions (see Table 2-2 below).

Temporal Data	Definition
Aggregation level	This defines the aggregation levels of the available temporal data (as in Table 2-1 above). The inputs for this column are numbers to depict the number of aggregation levels of the data.
Table	This column shows whether a NSO website that disseminates temporal statistical data using tables. The tables could be in PDF outputs or individualized table output.
Chart	This is to depict the dissemination of the temporal component of statistical data when bar or pie charts or graphs are used to visualize the output.
Multiple maps	This refers to the possibility to view two or more static maps of the same topic simultaneously to see the trend of temporal statistical data. This may be made possible by opening multiple window interfaces or by offering multiple static view maps of temporal data in one display.
Single maps	This records the possibility of dissemination of the temporal component of the

	statistical data through the use of a single map. This single map could be choropleth map, proportional symbols map or any other single map, showing for instance, the relative or absolute growth or decrease of population.
Interactive maps	This column records the use of interactive maps for the dissemination, retrieval and visualization of spatio-temporal statistical data on NSO websites. They can be mouse-over or clickable maps (Andrienko et al, 1999).
Animated maps	This column records the use of animated maps for the dissemination of spatio-temporal statistical data on NSO websites. Animated maps are maps with changing or blinking cartographic symbols or maps displaying data set by changing the cartographic method of representation of the map (Kraak et al 2003).

Table 2-2: The components and definitions of the temporal data section of the NSO inventory

Spatio-temporal statistical data as disseminated by NSO websites

- **Aggregation Level**: It was observed that although, 74.4% of the NSOs collect their census data on more than one aggregation level, only 50% disseminate these data on the aggregation levels in which the data are collected. Most of the NSOs disseminate their spatio-temporal data on only the national level, showing. An example is the Figure 2-3 below, showing the spatio-temporal statistical data of three different years and units of Bangladesh using table format.

BANGLADESH CENSUS RESULTS AT A GLANCE

Items	Census 2001	Census 1991	Census 1981
1. GEOGRAPHIC UNITS			
Zila	64	64	21
Upazila/Thana	508	490	477
Union	4 466	4 405	4354
Mauza	59 229	59 708	55 612
Village	87 362	86 038	83 666
Paurashava	223	107	79
Paura Ward	2 309	543	405
Mahalla	7 698	4 122	2 969
2. AREA (In sq. km.)			
Bangladesh	147 570	147 570	147 570
Urban	10 617	9 577	5 230

Figure 2-3: Temporal data collected at the 2nd aggregation level (Provinces) as available through the NSO website of Bangladesh (URL13)

- **Table**: From the results obtained from the analysis carried out on the NSO websites, the table proved to be the major method adopted by almost all the NSO websites. 72.8% of the NSO websites use table in combination with the other forms of disseminated methods in the dissemination of their spatio-temporal data, while 42% of NSO websites use only table as the form of output for the dissemination of their temporal statistical data. In the course of this research, it was observed that while some NSOs used single table to disseminate their temporal census data, others used multiple tables to disseminate their data as shown in the Figure 2-3. On some of the websites such as the Swedish website, users have the choice of selecting the

required years and also the option of viewing the output as tables or charts. An example is also shown Figure 2-4.

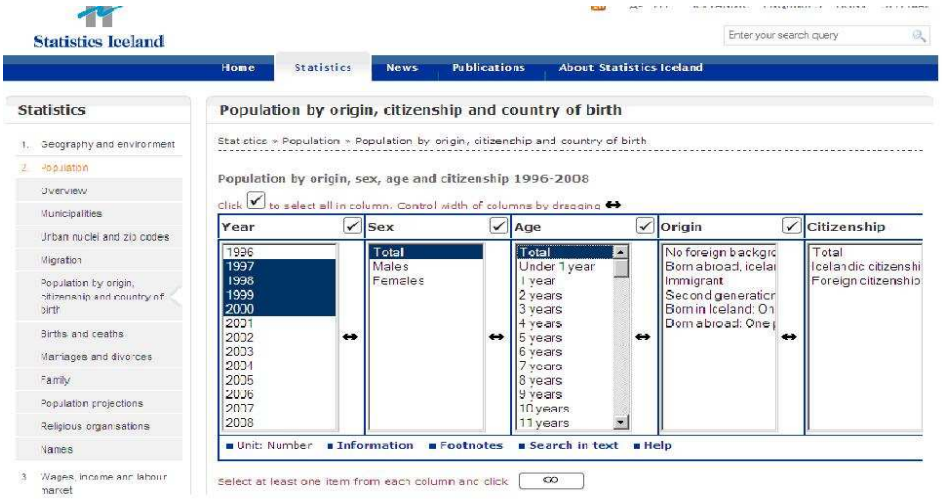


Figure 2-4: An image showing the possibilities of selection of only required data from the Iceland statistical website and having the output in table format (URL9)

- **Chart**: It was observed that 30% of the NSO websites use graphs, bar charts, pie charts and histograms in combination with the other methods described above to disseminate their temporal statistical data. Although most of the charts are images or diagrams, such on Czech Republic website (Figure 2-5), about 3.5% of the websites have interactive pyramids or charts on their websites, Andorra has interactive chart as shown in Figure 2-6 below.

Figure 2-5: Bar chart on the NSO website of the Czech Republic (URL8)

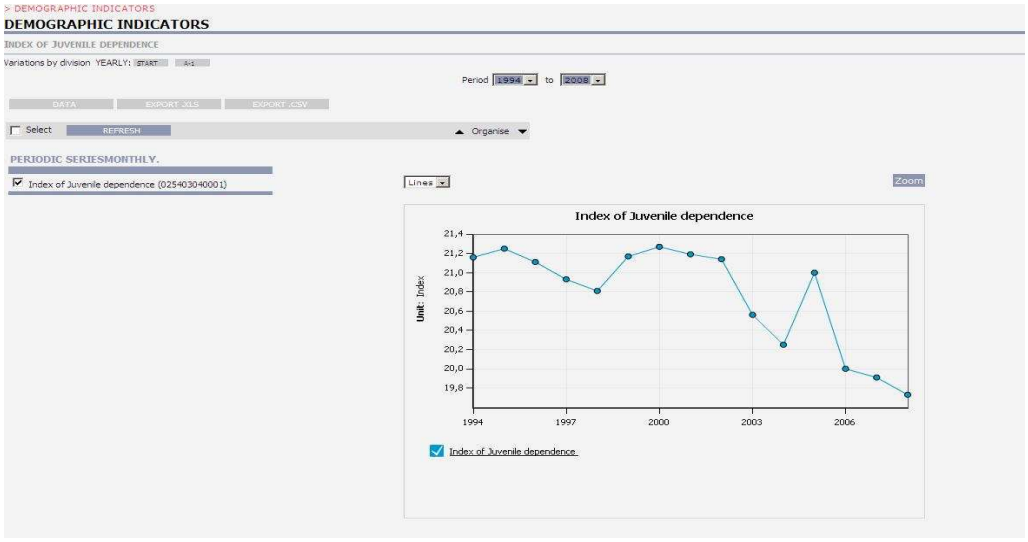


Figure 2-6: An interactive graph produced from population data of Andorra,1994 to 2008 (URL11)

- **Multiple maps**: It was observed that this is not a common method among the NSO websites and only 4.3% of the NSO websites made use of this method of dissemination and retrieval of spatio-temporal statistical data. On most websites, the maps can be opened separately in different windows and placed side by side to show the trends. An example of the use of multiple static maps is shown below (see Figure 2-7).

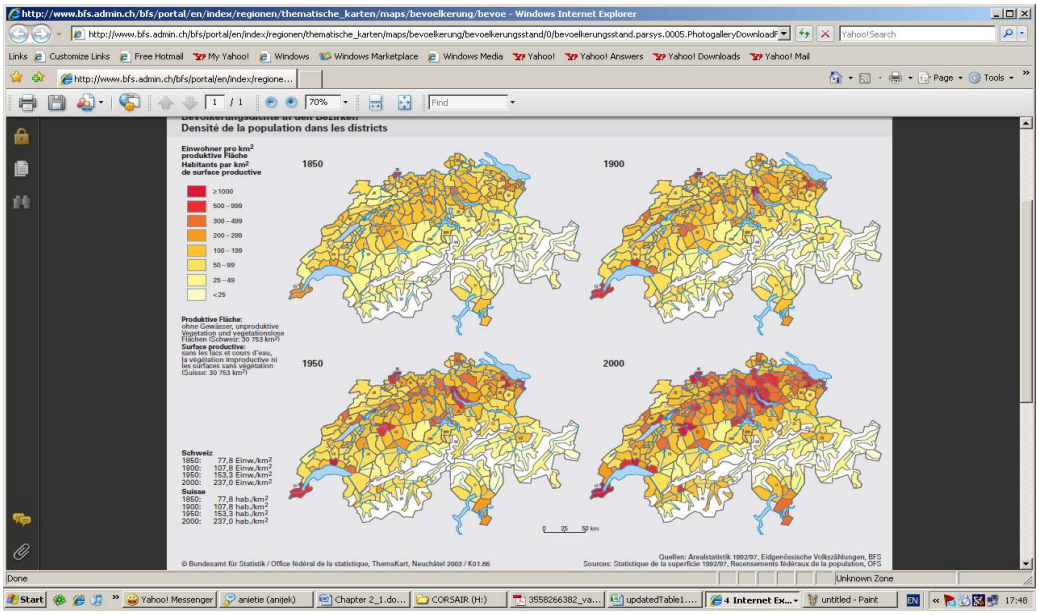


Figure 2-7: Multiple static maps of four different moments in time of Switzerland statistical data (URL2)

- **Single maps**: In most cases, as shown in Figure 2-8 and 2-9, NSO websites that offer this functionality, calculate the percentage change that had occurred in, for example, statistical data of two different moments in time. This percentage change is then mapped on a single map using cartographic variables, such as value and hue, to depict the changes. Although this method is more favoured than the multiple maps method, only about 6.5% of the NSO actually made use

of the single static map for dissemination of spatio-temporal statistical data. Uniquely, the Canadian NSO used a prism map, while the Czech Republic uses a cartogram to map population changes over series of years. Examples of both maps are shown in Figures 2-8 and 2-9.

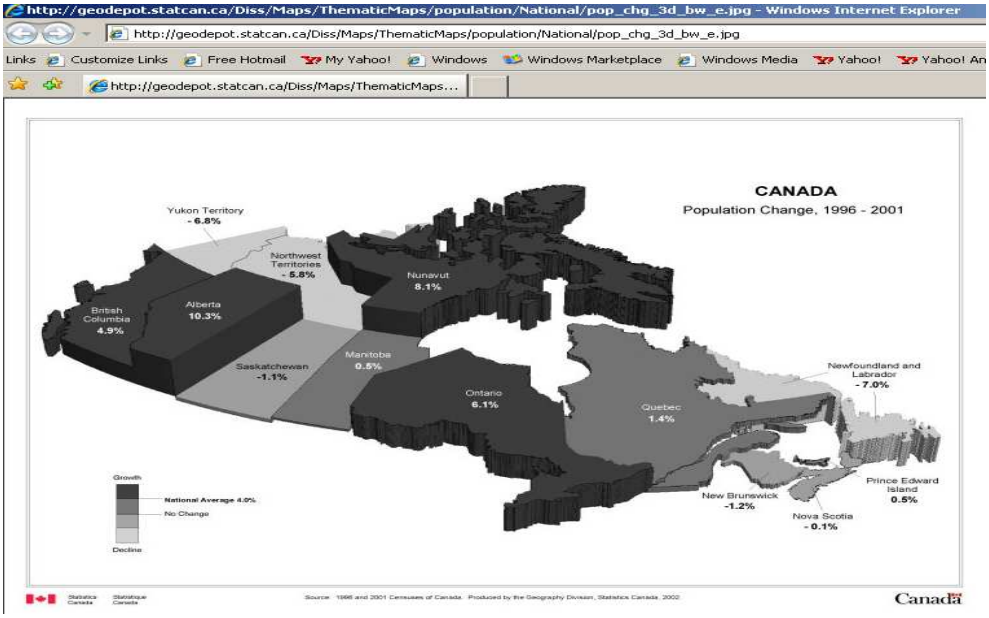


Figure 2-8: A prism map showing percentage change in the Canada statistical data on a single map (URL20)

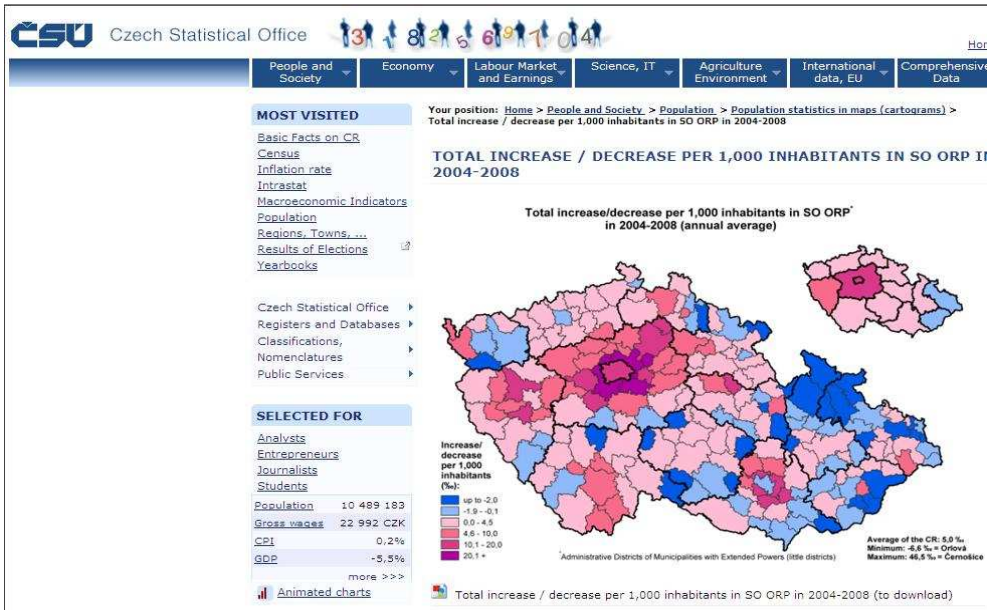


Figure 2-9: A choropleth map showing percentage change in the Czech Republic statistical data on a single map (URL8)

- **Interactive maps**: The use of interactive maps is not a common technology observed on the NSO websites and only 6% of the total population of the NSOs made use of any form of interactive map on their websites. The use of interactivity on the maps on these websites are

mostly restricted to clickable and mouse-over maps for dissemination of spatio-temporal census data. An example can be seen of such map is shown in the Figure 2-10 below.

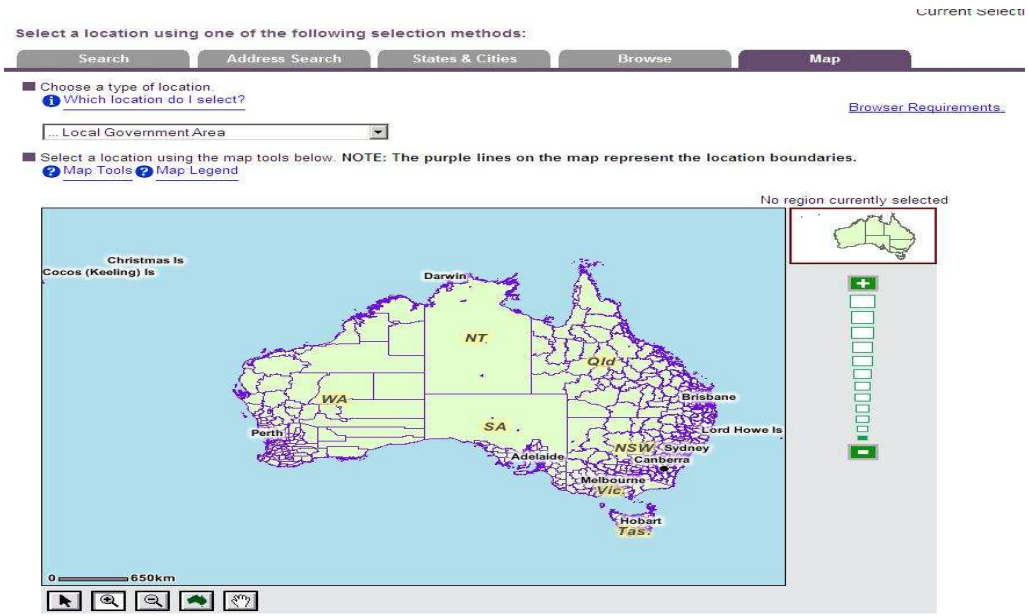


Figure 2-10:An interactive map of Australia statistical data (URL10)

- **Animated maps:** The dissemination of spatio-temporal data on NSO websites are limited to tables, charts (both image and interactive), single and multiple static maps, and interactive maps. No animated map was found on any of the NSO websites.

2.3.4. Update National Statistical Offices Switchboard

The national statistical offices switchboard was created by Redido-Cusi (2002) with 126 NSO websites. The switchboard was later updated in 2007(Van Elzakker, et al., 2007), where 187 NSO websites were found to disseminate their statistical data through the web. In the course of this research, this switchboard was updated to 199 NSO websites and also additional functionalities for dissemination, retrieval and visualization of spatio-temporal statistical data for all the existing websites were investigated and added. In order to update the NSO switchboard, some limitations were encountered. It was observed that about 11.4% of the websites still disseminate their data using only their official languages while 14.1% of the total NSO websites had links provided for an alternative language, mostly English. Unfortunately, most of these links are either not functioning or have no access to the statistical database. This was a major setback in the analysis of the dissemination of data on these websites.

Also, some of the websites had access restrictions on them, either by the need for registration before the data can be accessed, or the need to make some form of payment in order to view the data. In some cases, such as Afghanistan, there was total restriction on the accessibility of the NSO website.

2.4. Conceptual Framework of Spatio-Temporal Phenomena

In order to understand spatio-temporal data and its techniques of visualization, it is necessary to understand the what spatio-temporal data are. Peuquet (1994) developed a conceptual framework, popularly called the "Triad Framework" (see Figure 2-11), for the representation of spatio-temporal dynamics in the field of GIS. This framework serves as the foundation for many researches carried out today in the field of geovisualization as applied to GIS data. As mentioned above, the key elements of this framework are **where-when-what** and "time" is considered not as attribute of the data as it is done by the NSOs on their websites but as a dimension in a multi-dimensional dataset.
The framework permits the user to pose three questions which could be analyzed from three different angles:

When +Where-What
This angle describes the object or set of objects (what), present at a given location or set of locations (where) at a given moment in time (when).

When + What- Where
This describes the location or set of locations (where) occupied by a given object or set of objects (what) at a given time or set of times (when).

What + Where- When
This angle aims at determining the thematic and spatial characteristics of objects at a given moment in time or between two moments in time. Simply put, it aims at carrying out searches or queries of how objects or a particular location in space have changed between two moments in time. This third angle fits the purpose for dissemination of the spatio-temporal census data by the NSOs and could help answering basic questions any user of these data might have.

The Triad Framework

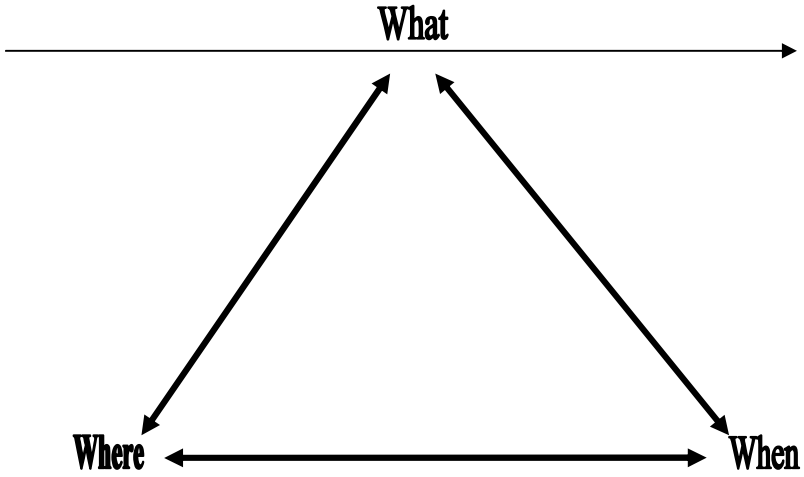


Figure 2-11: Basic components of the Triad Framework by Peuquet (1994)

The Triad framework is a generalized framework within which operational data models can be designed and customized according to the data and application range.

Based on the above framework, Andrienko et al., (2003) classified tools and techniques of visualization of spatio-temporal data into three groups, according to the kind of changes that occur over time in the geographic phenomena. This is to help researchers and developers in the field of geovisualization understand the different kinds of spatio-temporal data available and the right tools and techniques of visualization to apply.

Existential changes: This addresses the appearance and disappearance of the geographical phenomena in moments of time in a particular location. These changes deal with phenomena that exist only for a period. An example of an existential changes phenomenon is movement of fog in a particular area at a particular time. Examples of techniques for visualizing existential change are time labels, space-time cube e.t.c.

Location change: This addresses the **c**hange of the spatial properties: location, shape, volume of a geographical phenomenon. This change deals with describing how the environment/geography changes over time. It is useful for understanding dynamic of continuous phenomena as they affect the environment. An example of location change phenomenon is the rainfall measurement of different locations over time. Examples of technique for visualizing location change are space-time cube, trajectory lines, and time labels.

Attribute change: This addresses changes that occur in the thematic properties expressed through values of attributes. It describes phenomena with dynamic attributes i.e. features with attributes that changes over time, while location remain fixed. An example of Attribute change is spatio-temporal statistical data of a country, showing the change in statistical data for different moment in time for a fix location. Examples of such techniques are: time-series graph, change map and aggregation of attribute values.

2.4.1. Applications of Usability Evaluation and Geovisualization Techniques of Spatio-Temporal Data

Usability testing is defined as “the process of learning from users about a product’s usability by observing them using the product (Barnum, 2002). The aim of a usability test would be to find out about the need of the users relating to how they interact with a product and if it is effective, efficient and satisfying for the users. In geo-information science, the product could be a Mobile application, question that needs to be answered, electronics devices, software to websites (such as NSO websites for dissemination of statistical data, as in this research) and many more.

In a research by Babu (2005), on public transportation system, geovisualization techniques were used to explore the spatio-temporal patterns created by commuters travelling with different public transportation systems at different times.

The aim of the usability evaluation in this research was to aid the cognitive process of understanding the existing situation of the transportation systems, by creating some problem scenarios that commuters

could encounter by using the available transport systems. The output of the research was used to create new plans and policies for public transportation systems. In the evaluation, the focus group and Think aloud techniques were used to evaluate the prototype designed.

Bhowmick et al., (2008), using the UCD approach, developed an improved Pennsylvania cancer online interactive atlas. This atlas includes the use of maps, graphs and tables for data exploration and decision making with spatio-temporal cancer data. In order to assess the usability of initial atlas, the focus group and questionnaires survey were used in this research to obtain feedbacks from users of the atlas. The overall result of the research led to the development of functionalities for improving interactions functions on the atlas, temporal analysis and providing additional data displays and help function on the atlas.

Geovisualization techniques for visualization of spatio-temporal data

Geovisualization as defined by MacEachren et al., (1998) "is an extended form of traditional cartographic approaches for representing geo-referenced information, in which principles from cartography, GIS ,exploratory data analysis (EDA) and information visualization are integrated in the development and assessment of visual methods to facilitate the exploration ,analysis and representation of referenced data". It works by providing graphical ideation to render a place, phenomenon or process visible, enabling the most powerful human information-processing abilities-those of spatial cognition associated with the eye brain vision system-to be directly brought to bear". Thus, visualization is a cognitive process of learning through the active engagement with graphical signs that make up the display and differs from the passive observation of a static scene (Dodge et al, 2008).

The following researches below, explains the different fields in which geovisualization techniques have been applied as a tool for exploring and visualizing spatio-temporal data.

In a research by Blok et al., (2008), animated representation was applied to display the uncertainty and fuzziness in Dutch spatial planning maps. Although the research was limited to the animated representation by combination of both graphic and dynamic visualization variables, it was realized that the dynamic application of cartographic symbols increased the effectiveness and efficiency of the planners in making better decisions.

Also, Rae (2009) applied the flow mapping geovisualization technique to the analysis and visualization of the migration data from the UK 2001 census, in order to analyze the pattern movement of migration in UK. This helps to gain a better understanding of the residential mobility process at a national level. It also clearly shows an orderly and intelligible representation of continuous flow patterns that would otherwise remain unseen.

Overall, usability evaluation has been an important tool for understanding users' needs regarding dissemination, analysis and visualization of spatio-temporal data and these has contributed to the field of geovisualization. Thus, in this research, usability evaluation of existing NSO websites will be conducted using Nigerian and Swedish NSO websites as case studies, to determine the users'

requirement concerning dissemination, retrieval and visualization of spatio-temporal statistical data on NSO websites and an improved prototype will be developed.

2.4.2. Advantages of Geovisualization Techniques to what is being offered by the NSO Websites for Visualization of Spatio-Temporal Statistical Data

One of the major advantages of a geovisualization environment, is that, users may choose to display data in many different ways, thereby encouraging data exploration, and this increases recognition of pattern and abstraction of structure and meaning from data, and also brings to light subtle patterns and changes captured within complex spatio-temporal data that may not be immediately apparent when other forms of static or quantitative data analyses and visualization techniques are applied Edsall et al., (2000). Geovisualization techniques also provide the required tools for representation and manipulation of all three aspects of the data i.e. thematic, temporal and spatial simultaneously. It produces a strong visual effect on a viewer for analysis of trends and changes in the pattern of the data (Voss, et al 2000) and allows users to vary their needs between exploration and visualization of spatio-temporal data (Ogao et al, 2002).Unlike, what is present currently on NSO websites, geovisualization techniques are suited for emphasizing the changes between two moments in time, because they allow for explicitly incorporation of time in maps (Harrower, 2004). For example, animated maps are used to show geographic changes or processes over time unlike static maps which present all of their information simultaneously (Harrower, 2008).

2.5. Conclusion

Presently, spatio-temporal statistical data are disseminated by NSO websites using static methods of dissemination, retrieval and visualization of data such as tables, charts and static maps. These methods, though useful, are limited in the possibilities of proper dissemination and visualization of the temporal component of statistical data. Although few of these websites allow for interactive maps and charts such as population pyramids, there is still a far difference in what can be found on these NSO websites and what is been offered by current technologies for dissemination, retrieval and visualization of spatio-temporal data.

3. Requirement Analysis Phase

3.1. Overview

This Chapter gives the detail of the requirement analysis phase of the UCD. It gives an overview of the preparatory phases involved in conducting usability testing, how the usability test is conducted, the analysis of the test and summary of the result.

3.2. Introduction to Requirement Analysis

Usability is define by the International Organization for Standardization (ISO 9241-11, 1997) as "the extent to which a product can be used by specified users to achieve specified goals in a specified context of use with *effectiveness*, *efficiency*, and *satisfaction* (Van Elzakker, 2009; ISO 9241-11, 1997). Barnum (2002) defines usability to mean that people who use a product can do so quickly and easily to accomplish their own tasks. According to Rubin et al (2008), while relying on the above definition of usability, a product is truly usable when a user can do what he/she wants to do the way he/she expects to be able to do it, without hindrance, hesitation or question.

Usability testing is defined as "the process of learning from users about a product's usability by observing them using the product (Barnum, 2002). It employs different techniques to collect data while, for instance, observing representative end users using the product to perform realistic tasks. The aim of a usability test in this research is to find out about the needs of users relating to how they can retrieve, disseminate and visualize spatio-temporal statistical data on NSO websites and if the output is effective, efficient and satisfying for the users. In order to develop a usable product in a user centered project, the UCD approach is recommended and this involves conducting usability testing on the product, which in the case of this research, the Nigerian and Swedish websites.

Requirement analysis is the first phase of the UCD approach and an important stage of any user-centered project. This represents the big oval in Figure 1 of the UCD diagram and it is the phase where the basic requirements are determined and the problems encountered by users are also discovered. According to Lamsweerde (2000), requirement analysis is defined as a careful assessment of the needs that a system is to fulfil. It has the goal of identifying the purpose for which a product is developed, tasks to be solved by users of the product and likely problems users might encounter in using the product. Requirement analysis can also be carried out with existing products where improvements are made on the product or additional functionalities are included into the product and, sometimes, new organizations intend developing a similarly existing product (Dumas et al 1999). For the stated reasons, usability evaluation of already existing systems can be of great importance in the requirement phase of product development, for the product to meet the needs of its expected users. In this research, the Nigerian and Swedish NSO websites are analyzed in the requirement analysis phase by carrying out usability testing on the two websites and the output of the analysis will be used for developing an improved prototype of the Nigerian NSO website more suitable for users' needs.

3.3. Nigerian and Swedish NSO Websites as Case Studies

3.3.1. Nigerian NSO Website

Figure 3-1: The interface of the current Nigerian NSO website (URL16)

The Nigerian NSO website, known as the National Bureau of Statistics (nbs), is one of the 18 newly included websites in the NSO inventory originally created by Redido-Cusi (2002). The Nigerian NSO website disseminates its data using only English language. It provides a keyword search function and also a browse sector link to allow for quick accessibility to statistical data. Statistical data are disseminated using text, tables and charts, although currently only as a PDF documents.

TABLE 2: NIGERIA'S POPULATION OF NIGERIA BY STATE AND SEX

Number

STATE	1991				2006			
	Male	Female	%F	Total	Male	%F	Female	Total
Abia	1,125,999	1,212,488	51.8	2,338,487	1,434,193	49.4	1,399,806	2,833,999
Adamawa	1,050,791	1,051,262	50.0	2,102,053	1,606,123	49.3	1,561,978	3,168,101
Akwa Ibom	1,167,829	1,241,784	51.5	2,409,613	2,044,510	47.8	1,875,698	3,920,208
Anambra	1,374,671	1,421,804	50.8	2,796,475	2,174,641	48.0	2,007,391	4,182,032
Bauchi	2,192,423	2,158,584	49.6	4,351,007	2,426,215	48.1	2,250,250	4,676,465
Bayelsa	-	-		-	902,648	47.0	800,710	1,703,358
Benue	1,368,965	1,384,112	50.3	2,753,077	2,164,058	48.7	2,055,186	4,219,244
Borno	1,296,111	1,239,892	48.9	2,536,003	2,161,157	47.9	1,990,036	4,151,193
Cross River	956,136	955,161	50.0	1,911,297	1,492,465	48.3	1,396,501	2,888,966
Delta	1,271,932	1,318,559	50.9	2,590,491	2,074,306	49.4	2,024,085	4,098,391
Ebonyi	-	-		-	1,040,984	52.1	1,132,517	2,173,501
Edo	1,085,156	1,086,849	50.0	2,172,005	1,640,461	49.0	1,577,871	3,218,332
Ekiti	-	-		-	1,212,609	49.1	1,171,603	2,384,212
Enugu	1,475,648	1,678,732	53.2	3,154,380	1,624,202	50.1	1,633,096	3,257,298
Gombe	-	-		-	1,230,722	47.7	1,123,157	2,353,879
Imo	1,166,448	1,319,187	53.1	2,485,635	2,032,286	48.4	1,902,613	3,934,899
Jigawa	1,455,780	1,419,745	49.4	2,875,525	2,215,907	49.0	2,132,742	4,348,649
Kaduna	2,041,141	1,894,477	48.1	3,935,618	3,112,028	48.7	2,954,534	6,066,562
Kano	2,958,736	2,851,734	49.1	5,810,470	4,844,128	48.4	4,539,554	9,383,682
Katsina	1,860,658	1,892,475	50.4	3,753,133	2,978,682	48.6	2,813,896	5,792,578
Kebbi	1,035,723	1,032,767	49.9	2,068,490	1,617,498	50.1	1,621,130	3,238,628
Kogi	1,039,484	1,108,272	51.6	2,147,756	1,691,737	48.4	1,586,750	3,278,487
Kwara	773,182	775,230	50.1	1,548,412	1,220,581	48.5	1,150,508	2,371,089
Lagos	3,010,604	2,714,512	47.4	5,725,116	4,678,020	48.1	4,335,514	9,013,534

Figure 3-2: Table showing temporal population data of Men and Women per state in Nigeria as available on the Nigerian NSO website

POPULATION

FIGURE 1

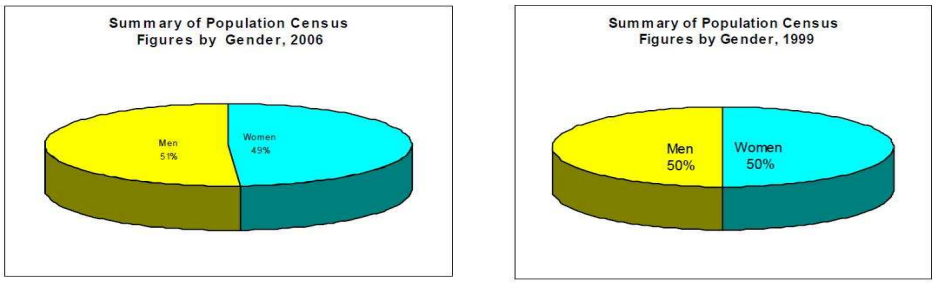


Table 1: NIGERIA'S POPULATION CENSUS FIGURES BY YEAR AND GENDER

Year	Total	Women	Men	%Women	%Men
1991	88,992,218	44,462,612	44,529,606	50	50
2006	140,003,242	68,293,683	71,709,559	49	51
Pop. Growth	3.82%	3.57%	4.07%	49.5	50.5

Figure 3-3: Pie-Charts showing percentage change in the Nigerian population data for 1991and 2006 on the Nigerian NSO website.

From the population link it is possible to locate links for various categories of population data but these links currently only lead to an empty database, therefore making it impossible to access data through them. The statistical data are disseminated for free in the PDF format that has to be extracted from a folder on the website. There is also an option for some form of registration on the website, but the option does not function as well. The statistical data are collected at the national and state aggregation levels.

Another important feature on the Nigerian NSO website is the availability of map images. These maps are of various states showing the ethnic distribution, land use, relief road networks etc but there is no map showing any statistical data, population distribution or population trend on the website. An example of maps found on the website is shown in Figure 3-4 below:

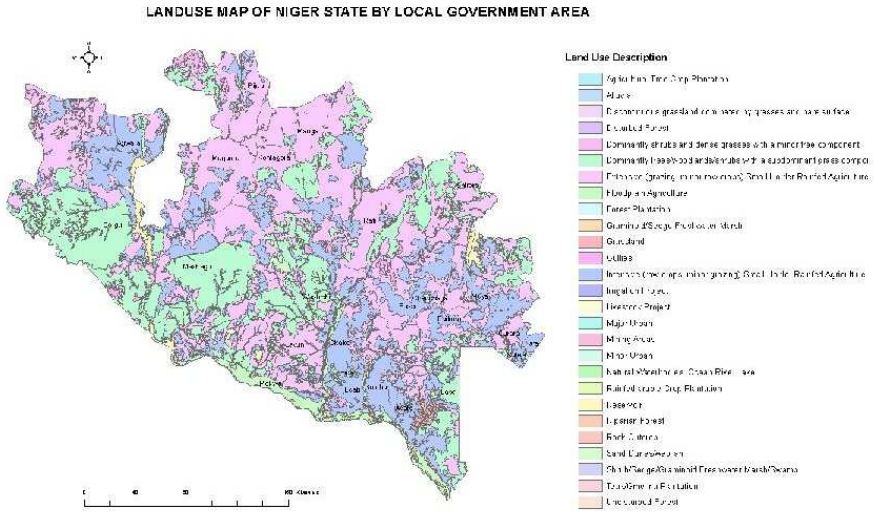


Figure 3-4: An image of a landuse map that can be found on the Nigerian NSO website.

Currently, the Nigerian website only offers temporal statistical data as tables and with few charts. It allows for download in PDF format and no form of interaction from the user is possible with these data. Temporal data are only disseminated at national and state levels.

3.3.2. Swedish Website

The Swedish website is a NSO website that offers the users the choice of two languages i.e. Swedish and English language. The website has a user-friendly interface with clear definitions of links to the information that can be accessed on the website. The NSO website offers a search functionality to allow easy access of data.

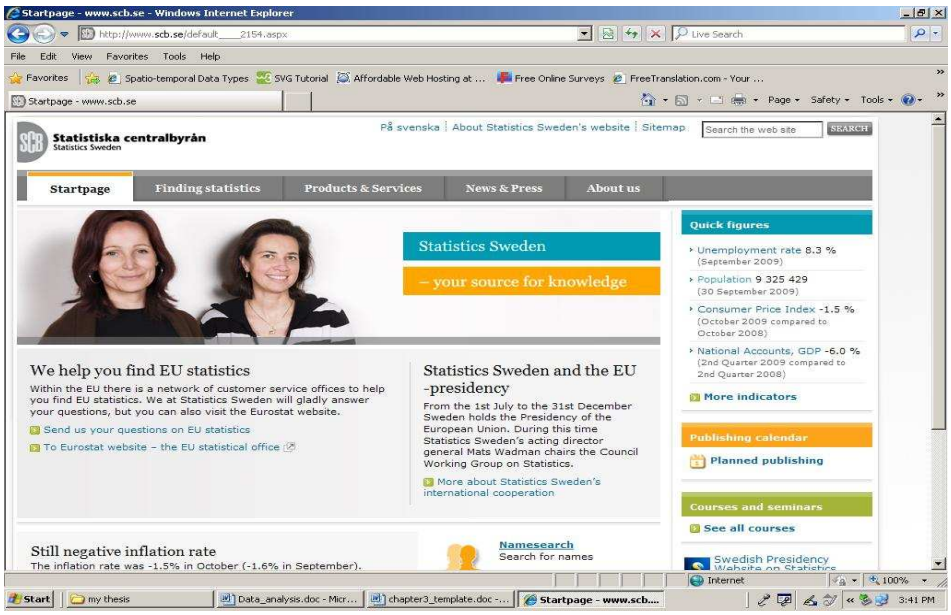


Figure 3-5: The interface of the Swedish NSO website with the English option selected (URL17)

The Swedish website offers the option of data download on the website and these statistical data and spatio-temporal statistical data are disseminated through tables, charts and maps. The website also allows for individualized output of statistical data through tables, charts and maps (although the map link did not work during the period of this research). The tables can be downloaded in different formats that allow for easy export into other map-making software for map production purposes.

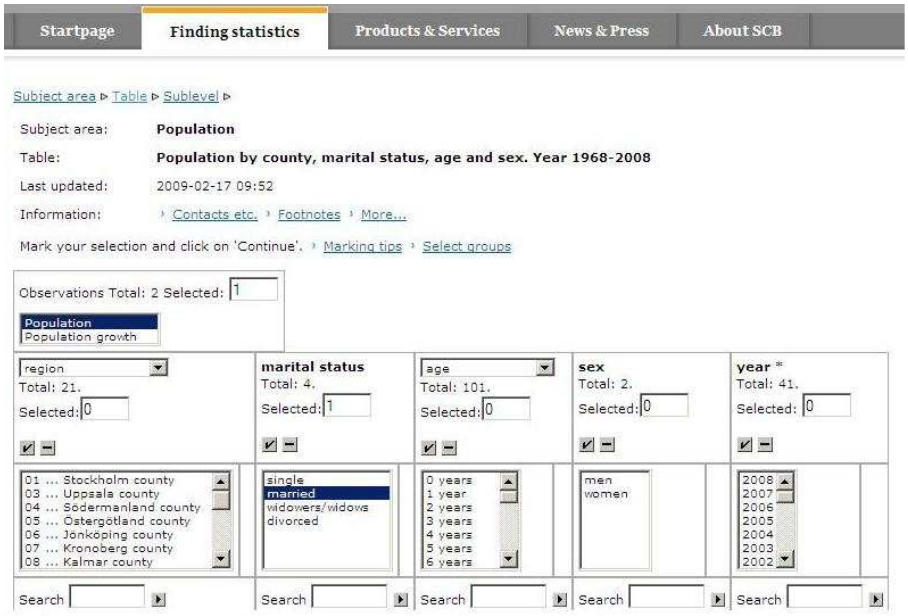


Figure 3-6: Selection options from the database for individualized output of data on the Swedish NSO website

The Swedish website currently disseminates its temporal statistical data through tables, charts, single and multiple static interactive maps. It also allows for individualized output of these data in all the four methods i.e. text, tables, charts, and maps, but as mentioned earlier, the map link did not work. There are also some predefined interactive maps for dissemination, retrieval and visualization of spatio-temporal statistical data. These maps only allow for selection of the years and they can be viewed both as multiple static view maps and as a single static trend map.

Figure 3-7: Table showing individualized output of temporal data along with options for map, chart, and text display on the Swedish NSO website

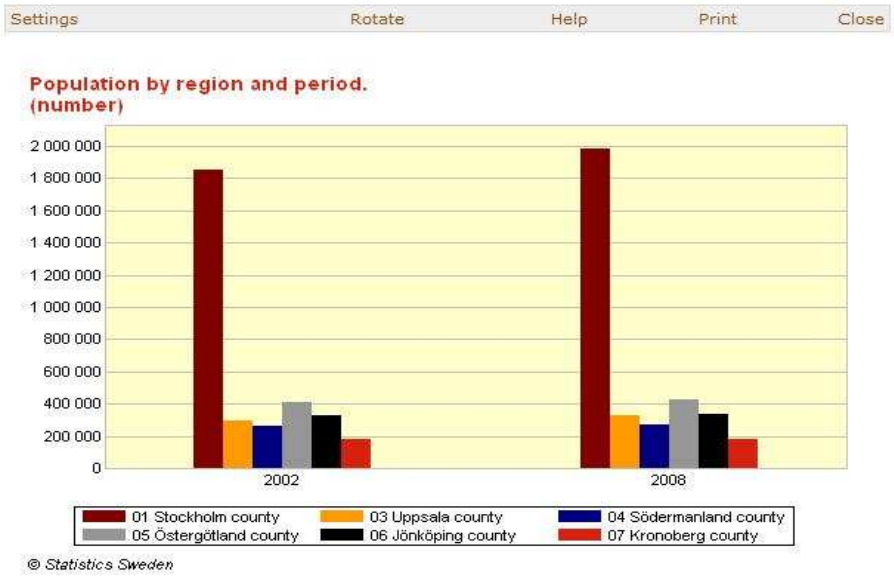


Figure 3-8: Chart showing individualized output of temporal data for six counties selected from the database of the Swedish NSO website

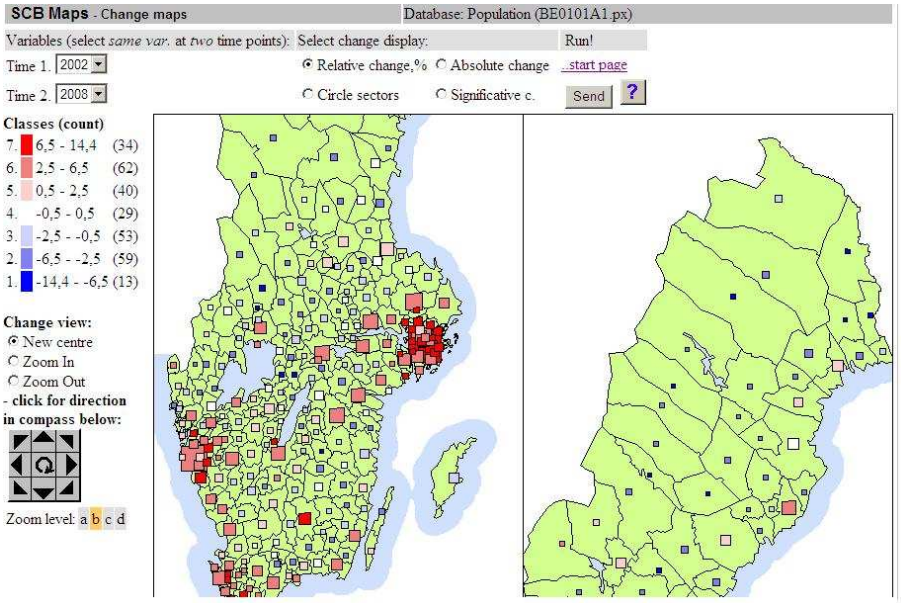


Figure 3-9: Single static interactive trend map showing population change of Sweden for 2002 and 2008 from the SCB maps

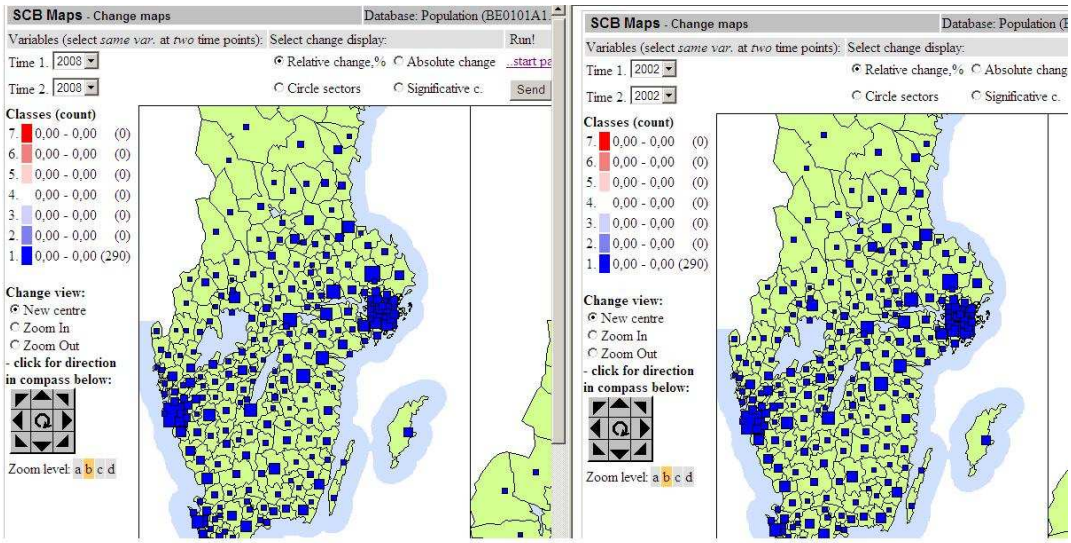


Figure 3-10: Multiple static interactive maps showing population distribution of Sweden in 2002 and 2008

It is possible to download temporal data on the websites and spatio-temporal data are collected and disseminated at 3 aggregation levels i.e. national, county and municipality level and these data are disseminated for free.

Interactive Map

The below Figure is an example of the single static interactive map that was found on the Swedish NSO website. This interactivity is use to retrieve the actual population data from the map by clicking on the map.

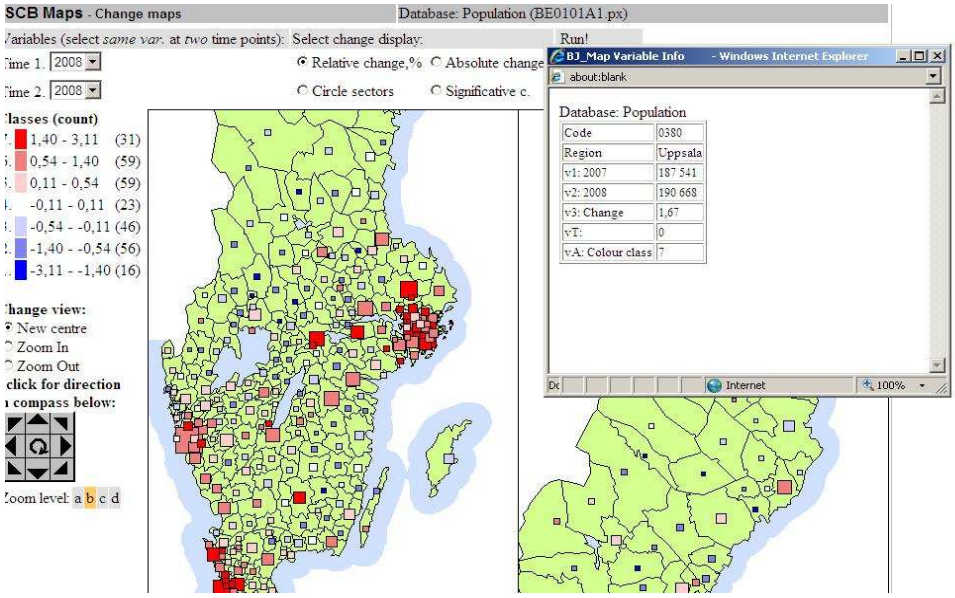


Figure 3-11: Interactive map showing population distribution of Sweden in 2002 and 2008

Animated maps

Based on the absence of animated maps on the NSO websites, the Canadian animated map (see Figure 12), would be used for the testing session. This is to give the test participants an idea of what animated maps are and how it is used for dissemination of temporal statistical data and how users can visualize these data.

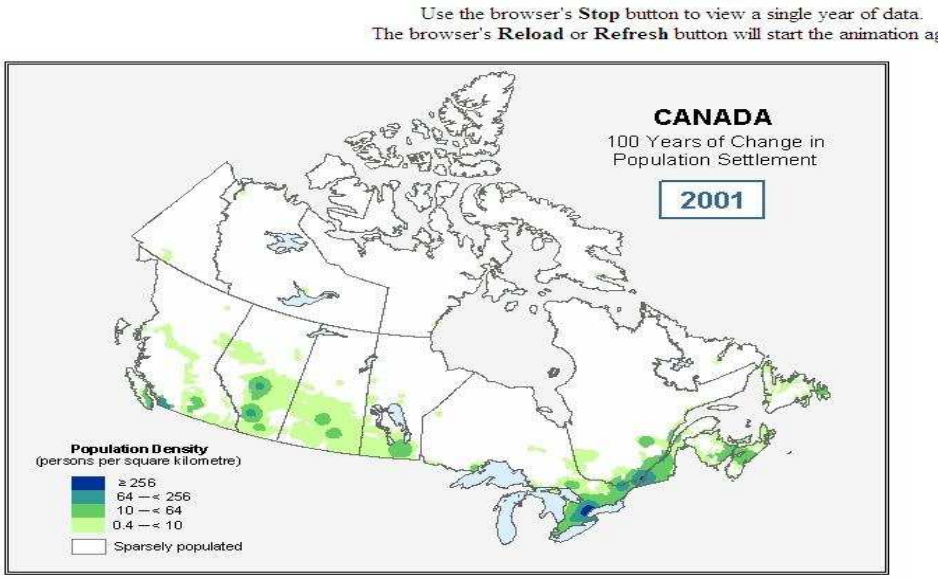


Figure 3-12: Animated map showing population distribution of Sweden in 2002 and 2008

3.3.3. Why Nigerian Website

The Nigerian statistical website was selected for the testing because an improved prototype of this NSO website will be developed. Studying the existing NSO website, it is very obvious that statistical data

and more specifically, spatio-temporal statistical data are poorly disseminated on this website when compared with some other NSO websites on the NSO switchboard. Statistical data and majorly spatio-temporal statistical data are disseminated using tables and charts on an Adobe PDF document. Since this is the home country of the researcher, it will be a way of contributing to the dissemination, retrieval and visualization of temporal statistical data on the Nigerian NSO website and allows for great improvement to be made on the website and in reality, solve a real life situation problem users of the website are currently facing

3.3.4. Why Swedish website

The Swedish website was selected as the second website for requirement gathering because, this website offers all the methods of dissemination, retrieval and visualization of statistical data analyzed in this research, except the animated map. It allows users to retrieve and download their data in the English language, unlike some of the other sites with the same functionalities which disseminate their data in only their official languages. The Swedish website also disseminates its spatio-temporal statistical data at different aggregation levels, making it possible to carry out analysis at regional/district level. Finally, it allows for individual output of the data as tables, charts, multiple and single static interactive maps.

3.4. Methodology

3.4.1. Scenarios and Tasks

Designing and Planning of the Requirement Gathering Test Session

The reason for any usability test is to determine likely problems users encounter using a particular product and then try to minimize these problems in subsequent design and production of such a product. These problems are translated into questions, which producers have to answer to improve the efficiency and effectiveness of the product. In order to translate the overall questions into tasks, the researcher has to prioritize the expected problems which have been asked by the research questions, break down the questions into sub questions and these questions are then framed in the form of tasks. The result of such a task, when completed, will be an answer or give insights to the problems that could be encountered at that stage, what are the likely reasons for the problems and how the problems can be solved.

For usability evaluation, combination of techniques is usually required to carry out a single scenario. The aim of creating scenarios is to define instances and tasks which would be carried out by test participants in order to analyze the effectiveness, efficiency and users' satisfaction of the product in fulfilling the required tasks. These scenarios can be expressed and analyzed from two angles:
The *researcher's scenario*: is a list in step by step format on how the researcher intends to conduct the test. It ensures accurate repeatability of the test for each and every test person
The *user's scenario*: is task list/instruction given to the user, explaining the required tasks expected to be performed by the user. This is basically used for investigating task execution and performance of users for development of a product. According to (Barnum, 2002; Dumas et al 1999; Mitchell, 2007), some of the characteristics of a good scenario are highlighted below:

a) A good scenario should be short.
b) It should express a user's perspective not the producers

c) Be clear and easy to understand by all participants
d) Give enough information needed to complete the task
e) It should express what are the problems are and the result should be able to answer the questions asked.

The major task of the design and planning phase of the requirement analysis in this research was to translate the research questions into tasks which would be executed by test participants and the output could be used for the development of the research prototype for the Nigerian NSO website. The requirement gathering was focused on testing the effectiveness, efficiency and satisfactory level of the existing Swedish and Nigerian NSO websites based on the dissemination, retrieval and visualization of temporal statistical data, and the tasks were designed accordingly. The first stage of the designing and planning of the test was to determine the NSO website that would be used as the case study, along with the Nigerian website. This was a very important decision because the success of the task was dependent on using the correct NSO websites for requirement data gathering. The Swedish NSO website was selected based on the reasons explained in section 3.3.4. The next stage was translating the research questions into questionnaires and tasks and these started with the designing of the questionnaires. The questionnaires were divided into two parts: the general and background and the post-test questionnaire.

The general and background questionnaire, as the title implies, had questions such as test participants' names, course and past experiences in using statistical data and NSO websites. This was to determine the level of experiences of test participants with working with the internet and map production software generally. The post-questionnaire was used as a form of base for an interview session, which would be carried out after the questionnaire and think aloud session. The questions were answered and recorded both audio and video. The post-questionnaire was used to gather data concerning the effectiveness and efficiency of the methods that could be found on the websites for dissemination, retrieval and visualization of spatio-temporal statistical data. This was to help understand how useful each method was from the users' perspective. It also contained questions about the users' opinion relating to the efficiency and effectiveness of the two NSO websites. The general task, which was to give the users the opportunity to determine the methods they would prefer to have on the NSO websites, were also designed during this designing phase.

Having designed the scenarios, tasks and questionnaires, the first supervisor was used as a pilot test participant and the whole process of the test was carried out. Modifications were then made to the tests and the pilot test was conducted again using the first supervisor. Then, the second supervisor was used for the third pilot test and the final modification was made before the real test participants were used. A total of seven test participants were finally selected and the schedule was designed for conducting the tests.

Conducting the test

The test was conducted in three major stages, the introductory and general and background data gathering stage, the tasks and scenario stage and the post-questionnaire and general task stage. All tests started with the researcher welcoming the test participants. This was carried out by the researcher reading the introductory note out to the test participants while they read along from copies given to them. The introductory note, (see Appendix 2), contains welcoming statement and expression of researcher's appreciation to test participants' positive response to being part of the testing sessions. It

states the research title and explains the aim of the research. It also explains the purpose of carrying out the testing session. It briefly describes the techniques used for the testing session and encourages the test participants; relax during the process of carrying out their tasks. The introductory note also contains information about how the test would be conducted and the estimated time needed for the tasks. The aim of the introductory note was to ensure uniformity and exactness in the information given to all test participants. This was also to stress the importance of speaking out loud during the execution of the tasks to the test participants. The test participants were then shown the test equipment. After the introductory note had been read, following the researcher's scenario, the test participants were given the first questionnaires to fill while the researcher opened the websites (Swedish NSO website, Nigerian NSO website and the Canadian animated map site) on the work station assigned for the tests. The test participants were then the given tasks sheets and some minutes to look through the tasks sheet and ask questions, if any, before commencing on executing the tasks.

Tasks involved

All test participants were asked to execute the predefined tasks on the two NSO websites selected and the Canadian animated website. The order for execution of the task, i.e. which task to start with, was alternated amongst the test participants. This was to determine whether the first task executed would influence the performance and needs of the test participants. The test participants were allowed to work without interference for the first five minutes of the testing session, and then given the instruction sheets on how to locate the data needed for the execution of the given tasks on the two website, when they are not able to find the required information. An instruction sheet was also provided for test participants for the retrieval of maps on the Swedish website. The researcher's help was also required for opening the multiple view windows needed for the multiple static maps.

After the execution of both tasks, the test participants were asked to answer the questions on the second questionnaire and the general tasks, and these were done in the form of interviews by the researcher and all responses were recorded both audio and video. General questions noted by the researcher, based on comments or actions of test participants during the execution of the tasks were also asked and responses recorded both audio and video. This was to allow test participants express their opinions about the tasks just executed and clarify comments made during the execution of the given tasks on the NSO websites.

Problems encountered during requirement usability testing session

The major problem encountered during this requirement gathering session was the recording of the test participant 3.This test, though was clearly executed and recorded like all other tests, but on checking the recording, had a sound problem. This test could, therefore, not be used in the analysis of the requirement gathering.

3.4.2. Test Techniques

Usability testing using the UCD is a method and has several techniques embedded into it. This is an important part of the requirement analysis, since the use of the right technique is important to obtain the right result. Usability testing can be either quantitative or qualitative. The qualitative techniques give non-numeric description (Usability.gov, 2009). Some techniques of qualitative methods are: (i) Introspection, (ii) Simple direct observation (iii) Think aloud (iv) Screen logging and (v) Focus groups.

On the other hand, quantitative techniques give numeric or statistical output. Some quantitative techniques include: (i) Questionnaires (ii) Eye-tracking and (iii) Performance measurement.

Three usability techniques are applied during the requirement gathering phase of this research. These include: the questionnaire, think aloud and interview techniques and these were used for the different stages of the testing session. These combinations of techniques were chosen because it allows for investigation of the users background and experiences with temporal statistical data and NSO websites, collection of test participants thoughts and actions during the execution of the given tasks and also allows for clarification of some of the problems encountered by the test participants (URL18, 2009; Usability.gov, 2009).

Questionnaire

The questionnaire technique is a technique where a set of questions is given to test participants for the purpose of gathering information about their attitudes, thoughts, behaviours or opinions of a product. In this research, the questionnaire technique was used in the first stage of the requirement gathering phase. This was used to collect background information on the test participants. The general and background questionnaire which had twenty questions was used to obtain some basics information about the test participants. This information included educational backgrounds of test participants, their working experiences with statistical data and/or NSO websites and level of experiences with the use of the internet for work purposes. Appendix 3 shows a copy of the questionnaire.

Think Aloud

Thinking aloud is a technique that requires test participants saying out loud what comes to their mind during the process of carrying out some predefined tasks or scenarios. Test participants are asked verbally to express their opinions, impressions about tasks they are executing and how the tasks are executed, problems encountered and whatever comes to their mind during the testing session. This is very important in a user centered design research as it gives the researcher an insight into what goes on in the mind of the test participants during the testing session of the product being tested. For this research, thinking aloud was used as the main technique for the requirement gathering phase of this research. Thinking aloud was used to record all the activities carried out during the testing sessions, starting from the introduction and questionnaire, to tasks and scenarios and finally the interview stage. Appendix 4 shows a copy of the tasks and instruction sheets executed by the test participants.

Interview

The interview technique can be of two types: structured and unstructured. The structured interview is a process where test participants are asked predefined questions, while in the unstructured interview, the researcher (or moderator) asks a single question and all other subsequent questions are derived from the answers obtained from the previous questions. For this research, the type used was more the structured interview although some other questions were also asked by the researcher for clarification of comments previously made by the test participants during the execution of the tasks. The interview was used in combination with the post-test questionnaire to collect more data about the usability of the methods available on the websites. This also recorded the test participants' overall impression concerning the usability of the Nigerian and Swedish NSO websites. Appendix 5 shows a copy of the interview sheet produced for the testing session.

3.4.3. Test Environment and Equipment

Another important factor is the test environment. This is basically determined by the product. The test environment should be similar to the environment under which the product will actually be used by users after production. Usability testing can be carried out in the laboratory, without a laboratory and on the field. The test environment is determined by the product being tested, the stage at which it is tested and the users of the product.

The requirement analysis usability testing of the Nigerian and Swedish NSO websites was carried out in the Usability laboratory on the first floor in the ITC building, see Figure 3-14. The laboratory is equipped with a video and audio camera for recording the activities of the test participants and the screen of the computer in order to record changes on the computer screen as test participants execute their tasks, an SVHS recorder and a synchroniser to synchronise the voice and images, see Figure 3-13.There is also an attachable microphone to record the voice of the test participants. There is also a big television screen to watch both the activities of the test participants during the testing sessions and to analyze recorded activities of the think aloud and interview sessions.

Figure 3-13: Test equipment for the usability requirement analysis testing session

The laboratory is also equipped with a computer to enable the test participants work on the selected websites. The test environment and equipment were based on the type of product being investigated (i.e. NSO websites) and the selected test techniques.

Figure 3-14: Test environment for the usability requirement analysis testing session

3.4.4. Test Participants

As mentioned earlier, UCD approach involves using real users to test the product/prototype. The success of any usability research depends on certain factors including selecting and testing the product with the right group of participants (a subset of the actual users of the product).The use of wrong participants can lead to two types of problem, namely, if the participants are more qualified than the actual users, the developer may be lured into a false sense of security about the effectiveness of the product, likewise, if the participants are under qualified, they exhibit more problems than the developer has to deal with.

The number of test persons depends on the technique selected although for the qualitative techniques, a minimum of four to nine test persons are required but more participants could be used especially for the quantitative techniques. In order to select suitable test persons, Dumas et al (1999) suggests the following process steps:

- Determine the various categories and characteristics of the intended users
- Create a database of likely users for each group of users
- Ensure that test persons have similar characteristics or experience as the intended users
- Determine questions to ask potential participants to determine which group of user they fall into.

As mentioned above, test participants should be a subset of the real users of any product in any usability testing. For this research, the test participants were Nigerian students who have graduated from/or are currently studying in ITC. These students were selected because they represent a subset of the general users of the Nigerian NSO website as can be found in the country and these students also have different levels of expertises in the use of internet for work purposes and little or no experience on the use of statistical data through NSO websites. For the testing session, a total of seven students (three females and four males) were selected but only six (two female and four male) recordings were used for the analysis due to a technical problem, an example can be seen in Figure 3-15. Although this was an unfortunate incident, it had little or no influence on the output of the rest of the testing session and the

final results of the test because the number was still within the recommended number necessary for conducting the usability testing.

Figure 3-15: Test participant in the usability requirement analysis testing session

3.5. Analysis of Results

According to Rubin et al (2008), the data obtained of any usability testing session can be analyzed in four major steps as implemented below:

- Compile and Summarize data
- Analyze data
- Result
- Prototype development recommendation

3.5.1. Compile and Summarize Data

This is a process that involves putting all data collected during the requirement analysis data gathering into a form that allows for pattern recognition. Data collected include data gathered during the testing through the recording, questionnaire, interview and the notes made by the researcher. The video and audio recordings of the whole testing session were first transcribed directly as it was recorded into texts by the researcher. These were then summarized in a tabular format according to each task and along with some quotes for each test participants for each individual website. The ratings for each task were also recorded along with each task. The questionnaires were also analyzed. The summaries were then further summarized into a more coincide and short statement. This was done for easy analysis of test participants' responses and for identifying patterns and similarity between statements made by test participants for each task and website. These data were compiled and summarized into different categories for easy data extraction. All transcribed materials, summary tables and extracted tables are included in the Appendix 6.

3.5.2. Analyze Data

From the analysis of the usability testing, two of the three themes, i.e. retrieval and visualization, which forms the basis for this research, were extracted. By analyzing the output of the requirement analysis gathering, it was observed that majority of the test participants had no clear understanding of how statistical data should be disseminated, retrieved and visualized and most especially, with spatio-temporal statistical data, priory to this testing session. Although, most of the test participants have the basic knowledge of what map displays are, but it was obvious that majority of them have no expectation of how these maps can be used for extraction of information of answers to their questions concerning changes occurring over time in a geographical location. Good examples were the responses obtained from the analysis of the test participants concerning the use of a single static map for data dissemination and visualization. More than half of the test participants could not understand the concept of the single static map and comments such as "I don't understand this map, how do I distinguish between the changes in the years" and "I can see population distribution but I can't understand or see the trend or distinguish the years", were asked by these test participants during the testing sessions. The most probable cause for this could be attributed to the poor cartographic variables and undefined legend, see Figure 3-9 and 3-10, used for the production of the maps on the Swedish website. Also, the majority of the test participants rated the use of a single static map for visualization of temporal statistical data as "difficult" and not a "must have" on the NSO websites. However, test participants were more comfortable and satisfied with the use of Single static interactive maps (i.e. single static map that is interactive).

In order to analyze the data, two charts were designed and analyzed. The first chart plotted show the task rating for each tasks executed and rated by the test participants and this ranges from very difficult to very easy, while the second chart show the important and requirement ratings of each method as rated by the test participants. These ratings are "must have = necessary", "could be nice = Not necessary but could be useful if added" and "not needed = it is not important".

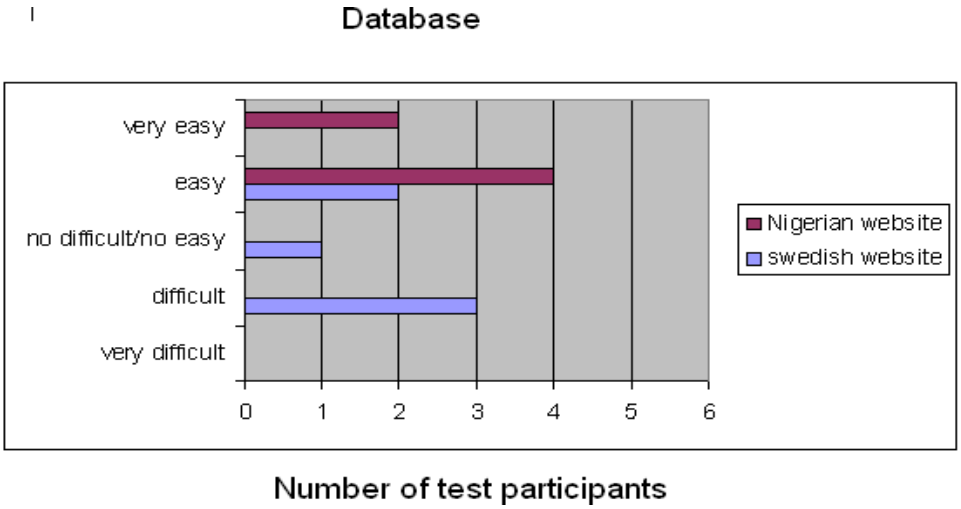


Figure 3-16: Chart showing the combination of the test participants rating for the retrieval of data from the Swedish and Nigerian database websites.

Looking at the Figure 3-16 above, it shows the rating of retrieving of data from both the Swedish and Nigerian websites. The majority of the test participants were not able to retrieve the required data necessary to carry out the defined tasks given to them during the testing sessions, but were only able to

execute the tasks after been given the instruction sheets by the researcher. This clearly shows that test participants were more interested in the possibilities of easy or direct retrieval of these temporal statistical data and animated and/or interactive visualization methods. Also, some of the methods were clearly not effective from the users' perspective for dissemination and retrieval of temporal statistical data. For instance; the multiple static maps on the Swedish website were clearly not effective for dissemination and visualization of temporal change of statistical data. See Figure 3-10 above.

Another example is the Nigerian NSO website. The majority of the users expected maps and charts as a means of visualization of temporal statistical data on this website but instead temporal data are disseminated as tables in a PDF file and most test participants were clearly not happy about it in their comments. For example, TP5 commented, "I will prefer an interface where I can select the required data. The world has gone beyond what is being offered by the website" and TP2 also commented, "I do not expect to be extracting and moreover, this is software dependent as well. I expect the data to be in a database". Based on these outputs from the testing session, it is very obvious that users are not satisfied with existing methods of dissemination, retrieval and visualization. Below are outputs of the analyses made from the testing sessions of the requirement gathering stage.

Interface

The chart below shows the combination of the output of the result of the users for the interface of the Swedish and Nigerian websites. Looking at the chart, it is obvious that majority of the test participants found the dissemination of statistical data on the Nigerian website more difficult than on the Swedish websites. From the homepage of the Nigerian NSO website, there was no easy link or access to the statistical data available on the website. Most test participants found it quite frustrating clicking so many links and still not able to retrieve the data.

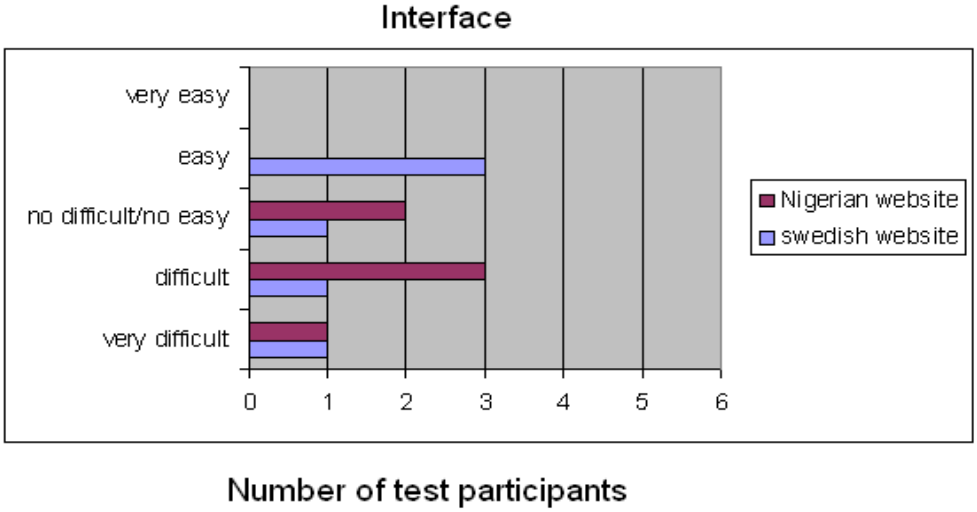


Figure 3-17: Rating of the interface of the Swedish and Nigerian websites.

By looking at the interfaces of both websites, there is a clear distinction in the process of retrieval of data from both websites. The Swedish website provides an interface for retrieval of data from the website, while on the Nigerian website, data are disseminated using a PDF documents. However, it is interesting to know that although all the test participants were not satisfied with this format of retrieval

of data on the Nigerian website, they still rated it more satisfactory than the Swedish website. This is probably due to the fact that users are more familiar with data in PDF format than the Swedish method of data retrieval.

Table

Tables are the most common method of dissemination, retrieval and visualization used by all NSO websites. From the output of the results obtained from the testing session, the majority of the test participants found the tables on the Nigerian website less effective than those on the Swedish website. This was due to the retrieval methods used by both websites. For the Swedish website, it was possible for test participants to retrieve just the required tables, while on the Nigerian website test participants could not interact with the data.

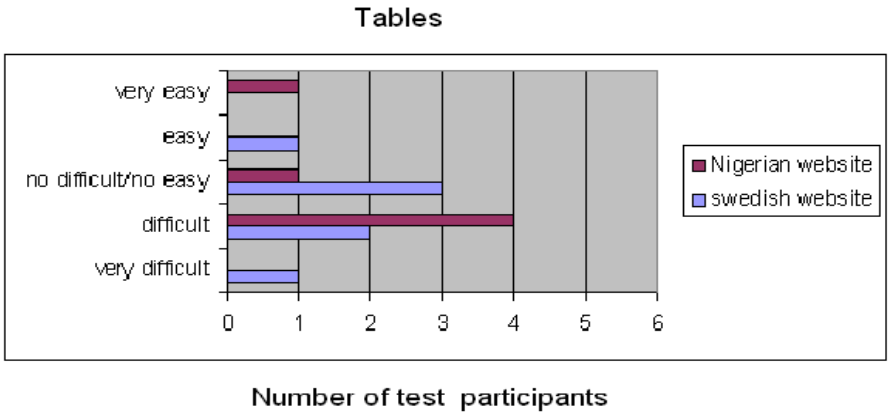


Figure 3-18: Test participants rating for the use of tables for the dissemination, retrieval and visualization of temporal statistical data from the Swedish and Nigerian websites.

Looking at the Figure 3-19, it is easy to see that most users consider the table an important and must have method for dissemination and retrieval of temporal statistical data.

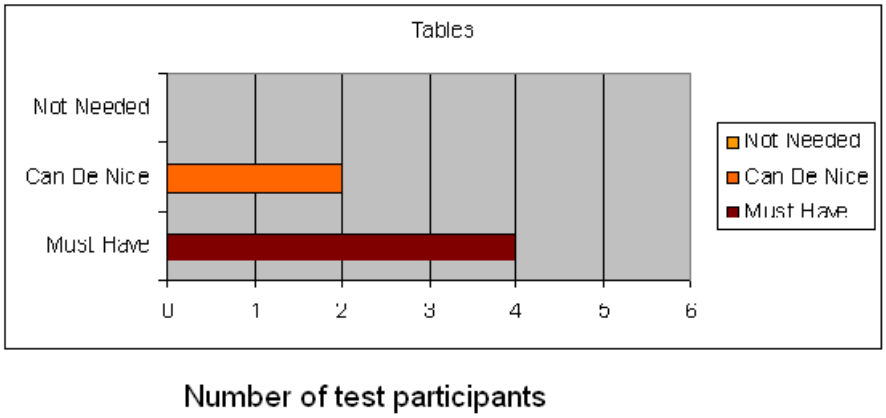


Figure 3-19: Test participants on the importance of tables for retrieval of data from the Swedish and Nigerian websites.

Overall, although tables are difficult to use for visualization of temporal data, test participants find it an important and necessary method on NSO websites.

Charts

From the observation made from the usability testing, chart as a method of visualization of temporal statistical data, was only noticed by 3 of the test participants and they all rated the use of charts for the dissemination and retrieval of temporal data effective.

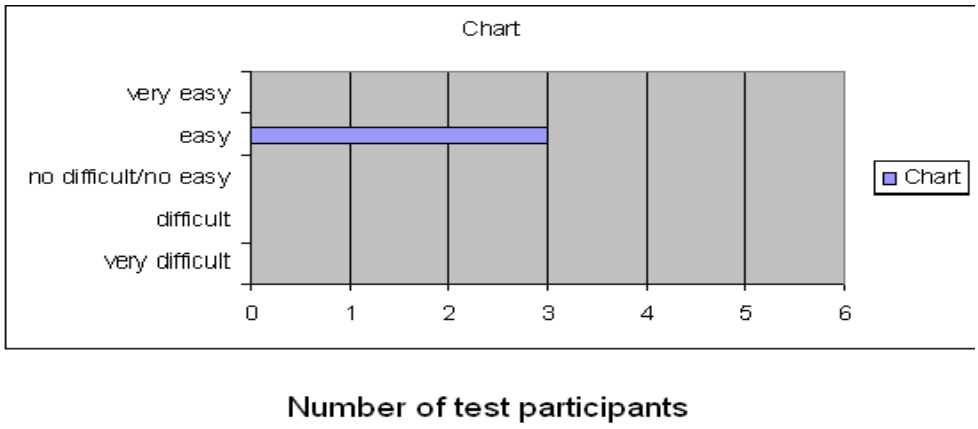


Figure 3-20: Chart showing test participants rating for the use of charts for retrieval and visualization of temporal statistical data on NSO websites.

Looking at Figure 3-19, only half of the test participants commented that the chart is very important for dissemination of temporal statistical data. Although three of the six test participants did either not see or recognise the chart icon used on the Swedish website, while the charts on the Nigerian websites covers only few aspect of the statistical data published on the website and none was used for answering or carrying out any of the questions and tasked asked during the testing session.

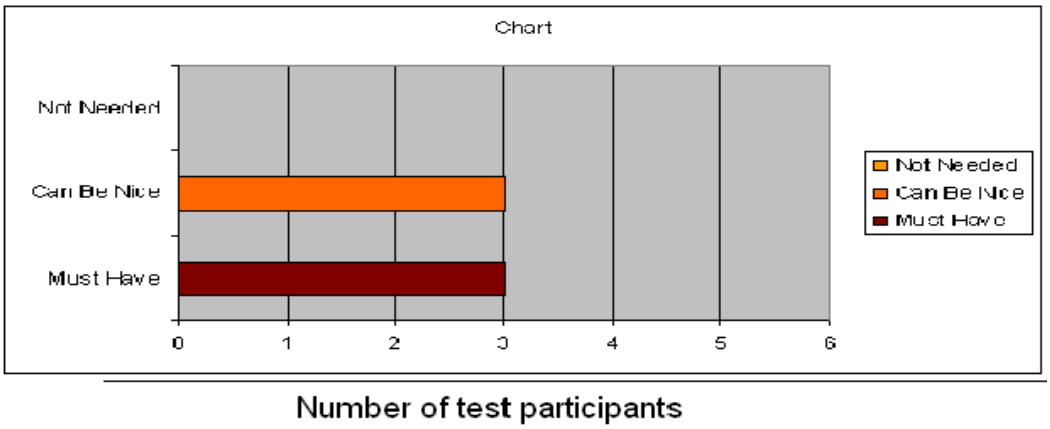


Figure 3-21: Rating of the test participants on the importance of charts for the retrieval of data from the Swedish and Nigerian websites.

Single Static Map (SSM)

The single static map was rated as difficult or very difficult by half of the test participants as shown in Figure 3-22 below. This was due to the fact that majority of the test participants could actually not understand the SSM as it was disseminated and retrieved on the Swedish website. As mentioned above, the major problem encountered by test participants when using the SSM was the poor cartographic variables used for the generation of the maps, see Figure 3-22. From the recordings obtained from the testing session, most test participants made comments on other maps they have seen and used and how poor and confusing the maps currently on the Swedish NSO website are. No map was found on the Nigerian NSO website for dissemination of spatio-temporal statistical data.

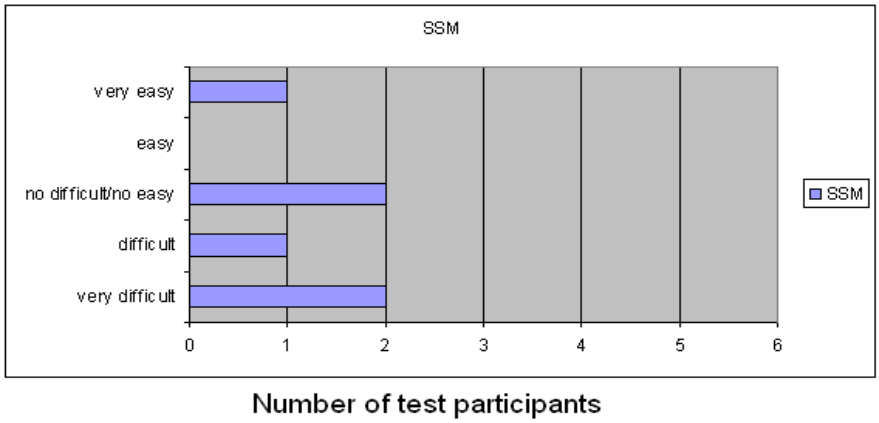


Figure 3-22: Test participants' rating for the use of a single static map for the retrieval and visualization of temporal statistical data on the Swedish website.

Although, looking at Figure 3-23 below, the majority commented that it was necessary or could be nice to have single static maps on a NSO website for the retrieval and visualization of temporal statistical data, but with better legend than what is currently available on the Swedish NSO website.

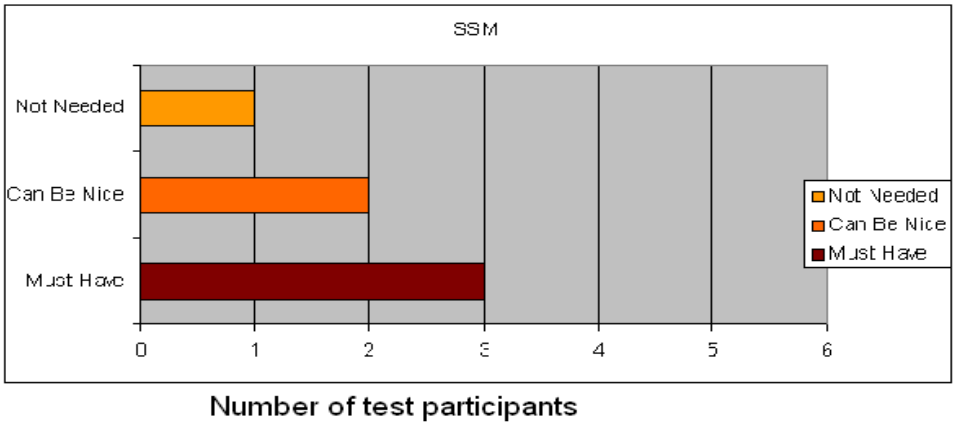


Figure 3-23: Rating of the test participants on the importance of single static maps for the retrieval of data from the Swedish and Nigerian websites.

Multiple Static Maps (MSM)

Like the SSM, the MSM was rated difficult by two of the test participant while three of the remaining five test participants rated it neither difficult nor easy to understand. However, by looking at the data collected during the testing session, majority of the test participants could not carry out the given task related to this method of visualization. This was probably due to the poor use and confusing cartographic variables used for the visualization of data on through the MSM on the Swedish website.

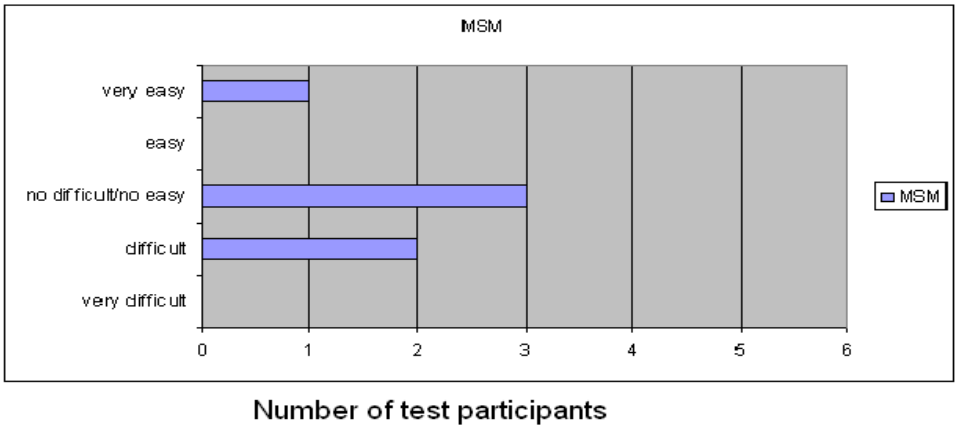


Figure 3-24: Test participants' rating for the use of multiple static maps for the retrieval and visualization of temporal statistical data on the Swedish website.

Also, like the SSM, the MSM was rated by the majority as a "must have" or "could be nice". For examples of the SSM and MSM maps as could be obtained on the Swedish website, see Figure 3-9 and 3-10.

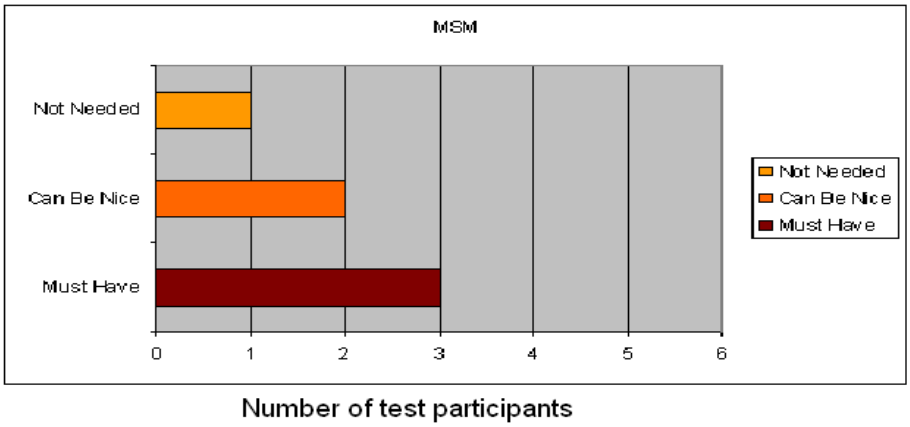


Figure 3-25: Rating of the test participants on the importance of multiple static maps for the retrieval of data from the Swedish and Nigerian websites.

Interactive Map

The interactive map, as shown in Figure 3-11, was rated as very easy and easy by all test participants and many made comments about its effectiveness for the dissemination, retrieval and visualization of temporal statistical data. It was most effective and satisfactory for test participants when combined with SSM.

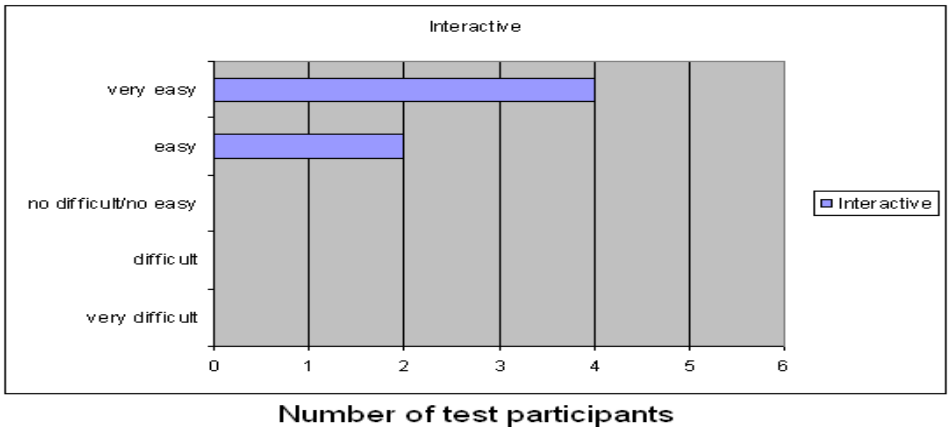


Figure 3-26: Test participants rating for the use of interactive maps for the retrieval and visualization of temporal statistical data on the Swedish website.

As can be deduced from Figure 3-27, all test participants rated interactive maps as a must have on NSO websites.

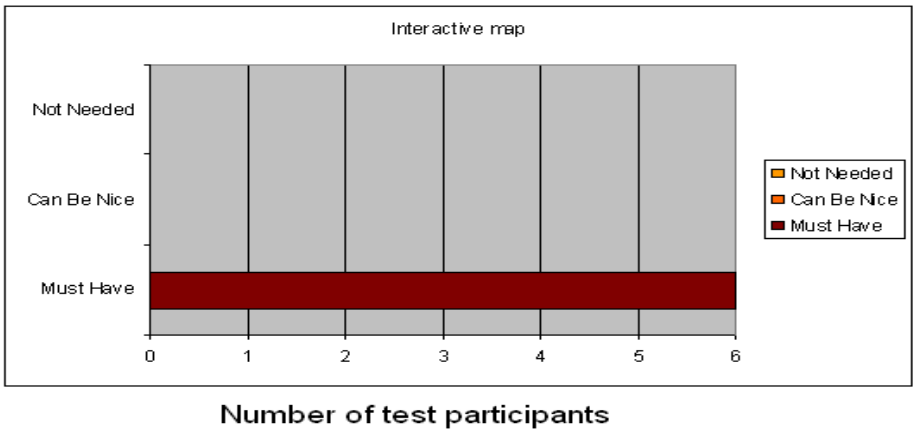


Figure 3-27: Rating of the test participants on the importance of interactive maps for the retrieval of data from the Swedish and Nigerian websites.

Animated Map

The animated map, an example is Figure 3-12, was another very popular method of visualization that was highly satisfactory from the users' perspective. Majority of the test participants rated the animated map as easy or very easy to use and to understand from their perspectives.

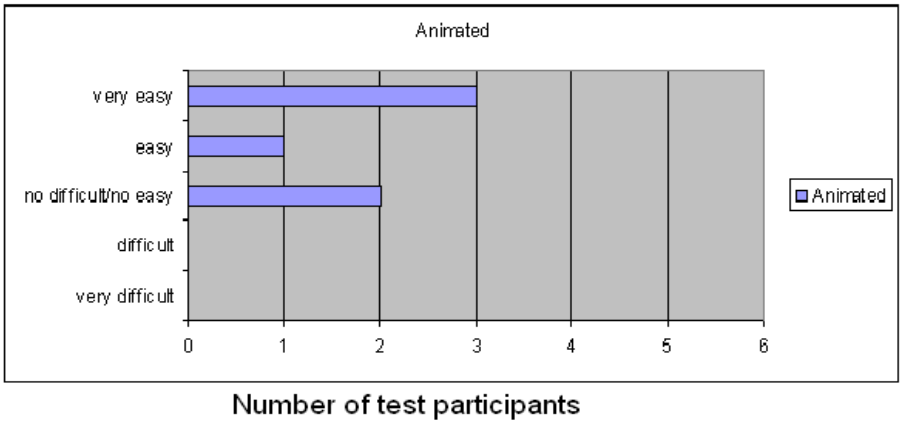


Figure 3-28: Test participants rating for the use of animated maps for the retrieval and visualization of temporal statistical data on the Canadian population distribution map.

Looking at Figure 3-29, it is obvious that almost all the test participants rated the animated map as a "must have" method any NSO website.

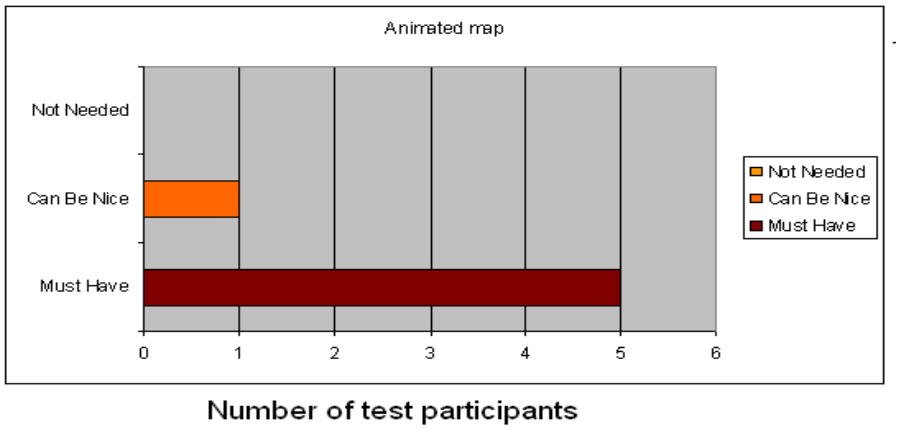


Figure 3-29: Rating of the test participants on the importance of animated maps for the retrieval of data from the Canadian population distribution map.

Although some of the methods, such as charts, interactive maps, and functionalities, such as the search function, currently present on the existing Nigerian and Swedish NSO websites are quite useful for the dissemination, retrieval and visualization of temporal statistical data, it was also quite obvious that there is need to improve on the existing functionalities, such as the interface, and include methods like maps and interactive and animation on the Nigerian NSO website from the users' perspective based on the usability testing conducted. All analyses are in Appendix 7.

3.5.3. Results

From the analysis of the usability testing, three themes (Dissemination, Retrieval and Visualization) were extracted, which forms the basis for this research. The overall results were focused on the effectiveness of the two case studies for the dissemination of temporal statistical data and users' satisfaction with the current methods available on these websites. The interface relates to how data are disseminated on the NSO websites and how easy it is for users to access the data. The database focuses

on how these data are retrieved on these NSO websites, while the tables, charts and the various maps focus on how these data can be visualized on these NSO websites.

General Task	**Result summary**
Interface	3 of the 6 TPs could not locate the data required for the tasks given for the Swedish website, while 5 of the TPs could not locate the data on the Nigerian website and had to rely on the instruction sheet given by the researcher. This simply implies that although the Swedish website has a friendlier interface than the Nigerian website, both interfaces are not so effective and satisfactory for the retrieval of data from users' perspective.
Database	4 of the TPs had problems understanding the retrieval interfaces of both websites. On the Swedish website, the interface was quite advanced in the technology applied and users could not really understand how to extract the required information while on the Nigerian website, the data were stored as PDF and therefore impossible for users to interact with.
Tables	Majority of the TPs insisted that tables are important for dissemination and retrieval of spatio-temporal statistical data, but only 2 of the TPs commented on its usefulness for visualization of temporal statistical data. All TPs agree tables are very necessary for analysis and data storage, in order to produce the other forms of visualization methods. They also commented that tables should not be the only means of visualization as could be found on the Nigerian website because it is tedious and cumbersome for analysis especially when there are large volumes of data and years to visualize.
Charts	Majority of the TPs favoured the use of charts for the visualization of temporal statistical data. The TPs all agreed that it gives a quick overview of the changes that had occurred over the years and it is a good means of visualization for overview of spatio-temporal statistical data on NSO websites.
Single static maps	None of the TPs could really understand the use of the single static map for the dissemination of temporal data as presented on the Swedish website due to the confusing legend on the map. It was also clear for the testing that the users do not understand the use of single static maps generally. Most test participants could not successfully analyze the trend and population change through the use of this method.
Multiple static maps	Like in the singles static map, none of the TPs could understand the multiple static maps on the Swedish website, and they all claim that the maps were more confusing rather than being helpful. It was also clear that test participants could not differentiate the differences between the two maps even though they were for different time series. They all commented that the use of better cartographic variables for visualization of spatio-temporal data using this method is necessary.
Interactive maps	All TPs commented on the fact that the use of interactive maps for the dissemination of spatio-temporal statistical data on NSO websites cannot be overemphasized. They commented on the effectiveness of this method for dissemination of the actual value of the data by clicking on the map while at the same time, still possible to visualize the changes on the maps. Also, the data retrieved through the interactive maps can also be use for simple analysis to determine the trend of change over the selected years.

Animated maps	All TPs agreed that the use of animated maps is the current and best way for visualization of any changing data such as spatio-temporal statistical data. They all commented on the ease of understanding the distribution pattern and the trend or changes that occur within the data over the years by just looking at the map and they all agreed that it is a must have method on the website. However, they all commented on the fact that it would be more useful if the animated map could also be interactive with an opportunity to stop and retrieve the actual data behind the animation at anytime needed by the user.

Table 3-1: Summary of the testing sessions of the requirement gathering phase

Based on the results obtained from the testing session and shown in Table 3-1, it was deduced that some of the existing functionalities, such as the interface and data retrieval methods, and some methods, such as tables and charts available, most especially on the Nigerian NSO website, are not effective in satisfying users' needs for dissemination, retrieval and visualization of temporal statistical data.

3.5.4. Prototype Development Recommendation

In developing a prototype for the Nigerian NSO website, certain factors have to considered based on the results obtained from the users' requirement analysis gathering session. Some of the factors to be considered for developing an NSO website that is effective, efficient and satisfactory for dissemination, retrieval and visualization of spatio-temporal regional statistical data from the users' perspectives are: the different categories of users of the NSO website, level of knowledge of the users in visualization of temporal statistical data using the various types of maps available and use of the internet for work purposes.

Based on the output of the usability testing session, animated, interactive, tables, single static and multiple static maps will be used for retrieval and visualization of spatio-temporal data on the prototype NSO website. Although for the testing session the Canadian population density animated map was used, but according to (Babu, 2005; Blok, et al., 2008; Goldsberry et al., 2009; Griffin, et al., 2006), there are different types of animated maps, and a few will be implemented on the prototype and tested by users for the prototype evaluation phase of this research. The use of the proper cartographic variables for mapping purposes and well defined legends will be inculcated on the prototype.

3.6. Conclusion

The overall impression of the test participants was that the Swedish website has a more user-friendly interface and it is much better and advanced in the dissemination, retrieval and visualization of temporal statistical data on the website and that there is a great need to improve on the Nigerian website for both the interface and also for better dissemination, retrieval and most importantly visualization of these data.

In summary, it is very obvious that the three keywords, i.e. effectiveness, efficiency and satisfaction, of a user centered design are not met by the Nigerian NSO websites for the dissemination, retrieval and visualization of temporal statistical data from users' perspective. There is therefore the need to develop

an improved prototype of this NSO website while taking into consideration the results of the requirement gathering testing session.

4. Prototype Design and Implementation

4.1. Overview

This chapter gives an overview of the design and implementation of the prototype. It defines the functionalities of the prototype based on the data gathered from the users' requirement analysis. From the requirement analysis phase, test participants were asked to execute some tasks. The aim was to gather information on the usability of existing NSO websites for the dissemination, retrieval and visualization of spatio-temporal statistical data. During the testing sessions, the interfaces of two NSO websites, the data retrieval techniques and the usability of the methods i.e. tables, charts, single static, multiple static, interactive and animated maps were tested.

4.2. Introduction

The prototype design is the second phase in the UCD approach. This phase deals with the designing of the prototype and this designing is in three stages: the conceptual design, the interim design and the final design, see Figure 1-1. The conceptual design stage is the first stage in any prototype design. It involves defining a plan for the development of the prototype. In a UCD approach, the conceptual design is developed based on the result obtained from the requirement analysis phase. Based on the conceptual design, an interim design is developed and this is tested by the developers to detect faults. The final design stage involves development the prototype as it would be released to the users. The prototype design phase of the UCD is an iterative process, which usually involves given the developed prototype to test participants in order to detect errors based on users' perspective and then corrected before being released to the final end users of the prototype.

In this research, the prototype was designed based on the output of the requirement analysis testing. Test participants comments based on how spatio-temporal statistical data should be retrieved and visualized were translated into a conceptual design and this was finally developed into the prototype.

4.2.1. Retrieval of Spatio-Temporal Data from the Swedish and Nigerian NSO Websites

The retrieval process on the NSO websites were investigated in two ways: the interface and the methods in which the data could be retrieved. For the interface, test participants found the Swedish website more user-friendly than the Nigerian website. The users were able to navigate through from the home page to the database of the Swedish website easier than on the Nigerian website. From the analysis of the requirement phase, it appeared that only half of the test participants were able to locate the data while only one test participant was able to locate the data on the Nigerian NSO website. Most test participants commented on the fact that the Swedish website is more user-friendly. For example, TP 4, commented that "the Swedish site at first glance has a user interface that is friendlier that the Nigerian website", and TP 2 commented that "this is very ok. This is more elaborate and you can just click on it", while TP 2 also commented on the difficulty of using the Nigerian NSO website, "I do not expect it to be so difficult like this and I still cannot find it. An impatient person will have given up because I would expect to be able to get the information under few minutes" and TP 4 commented that

"it is not a simple or straight interface created for data dissemination". Overall, the Swedish website is more user-friendly than the Nigerian website although the there is need for improvement on the interface of both NSO websites to allow for easy retrieval of spatio-temporal data by simple clicking on the map and also easy navigation within the website.

It was observed that the retrieval methods on the Swedish and Nigerian websites were quite different. On the Swedish website, users have the opportunity of selecting the required data from a database while on the Nigerian website data can only be retrieved in PDF format. It was also observed that the Swedish NSO website was developed for users with high knowledge of the use of computer for work purposes, and from the output of the test, the Swedish interface, though better than the Nigerian NSO website interface, was not easy to use for users with little knowledge of internet for work purpose. From comments of test participants, such as TP 5, "it is not following a standard and not easy to understand. I will also expect the search function to be able to give me directly the required information" and TP 7, "this website seems a bit clumsy". It was obvious that most test participants found the database confusing and difficult to use. Although test participants could understand the retrieval format on the Nigerian NSO website more easily, they were not quite satisfied with the method on this website. TP 5 commented "I don't think Nigerian website has an environment for data dissemination on this page" while TP 2 commented "I do not expect to be downloading and extracting". Based on these results, for the prototype, an easier way than what currently exists on the NSO websites for data extraction will be used for the prototype.

4.2.2. Visualization of Spatio-temporal Data on the Swedish and Nigerian NSO Websites

The visualization of spatio-temporal statistical data on the NSO websites is done using tables, charts, single static maps, multiple static maps and interactive maps. For the table as a method of retrieval, most test participants found it tiring and stressful for visualization but they all recommended it as important on NSO websites for data storage and downloading. For example, TP 2 commented; "use of table for analyzing is like water and blood to the humans, you can do without them although you still need map to complement it". This comment simply means that tables are important and necessary for dissemination of data on the websites but they should be complimented with maps for visualization purposes. Chart was a method that was favoured by half of the test participants as a method for visualization of spatio-temporal data but TP 4 commented "charts become clumsy with increase in the number of years". The use of single static maps and multiple static maps were the least favoured by the test participants. This could be basically because these two maps as can be retrieved on the Swedish website are not created with the proper cartographic visual variables (value, colour) and have poor legends. The majority of the test participants found the maps confusing and difficulty to understand or to differentiate trends on them. TP 4 commented that "the two maps for the different years in the multiple statics are not showing much difference. This give me the impression that visualization of changes on the two maps is not quite possible", TP 5 commented "I don't understand this map, and how do I distinguish between the changes between the years", while TP 7 also commented "I can't see much difference between the 2002 and 2008 maps. There could have been an improvement in the representation (cartographic variable), it is not so visible and the understanding is hampered or limited". Finally, for both the animated and interactive maps, test participants found both methods very effective and satisfactory for the visualization of trends and changes that occur in spatio-temporal

statistical data and all test participants commented on how effective the animated map would be if it is also interactive.

Based on the overall results of the usability testing, the user interface design and the data retrieval on the prototype will be made as simple as possible. The table will be used for the dissemination and retrieval of data as download and to give quick overview of the data but not for visualization purposes in the prototype, while animated and interactive choropleth and proportional symbol maps, along with multiple static maps with well defined legends and proper cartographic variables will be used for the visualization of spatio-temporal data on the prototype.

4.3. Conceptual Design of the Prototype

Based on the results of the requirement analysis, the conceptual design of the prototype was developed. In designing the prototype, certain factors have to be considered, as such:- the levels of computer literacy of the prospective users . This is important in the designing of the interface and the retrieval method of the spatio-temporal data in the NSO prototype. Therefore, the interface will have only the minimum selective possibilities. Another factor considered in the conceptual design of the prototype is the level of knowledge of the users in the visualization of spatio-temporal statistical data using the various types of maps available. This is very important because, although maps give a good visualization of spatial distribution of data compared to tables and charts, it might prove confusing for users with little knowledge of map use. Based on the output of the analysis of the requirement analysis phase, the prototype will be made as simple and easy to use as possible.

In the conceptual design of the prototype, the layout was divided into three major pages.
The first page of this prototype is the interface page of the Nigerian NSO websites. This page will be designed to contain definitions of the types of methods and maps that are available on the prototype, time selection and also allows for selection of the map required.

The second page would be created for dissemination of the choropleth, proportional symbol maps and single static maps. The interface will contain buttons to control the map, a window to allow for direct loading of the selected map type into the window, a pop-up window for the retrieval of the actual population data for each state and the legends.

The third page of the prototype is designed to contain the multiple static maps. Based on the requirement analysis, the majority of the test persons were not able to compare the maps for two different years together easily due to the inability of placing them side by side on the same page. For the requirement analysis testing, users were required to open two windows and place them side by side to allow for comparison of two maps. However majority of the test participants could not achieve this objective. Therefore, this window is divided into two parts, one for each map. This is to ensure easy opportunity for users to compare two maps of different years.

Although in the conceptual design, three pages were designed, however for in implementation of the prototype, additional pages were created for the retrieval of the different methods available in the prototype.

4.4. Implementation

4.4.1. Software and Technology

Flash CS4 Professional and ArcMap were the software adopted for the implementation of the prototype in this research. Flash CS4 Professional is a product of the Adobe Creative Suite, which is a collection of graphic design and web development applications made by Adobe Systems. Adobe CS4 Professional is software with a friendly user interface that allows for developing animated maps and publishing them on the Web. This software allows for easy use with little knowledge of programming. The software uses action script as it underlying programming language. CS4 Professional was chosen by the researcher because of the little knowledge of programming that would be required in using the software and also because of the availability of detailed help functions for using the software.

4.4.2. Spatio-Temporal Statistical Data

As defined earlier, the Nigerian population data are spatio-temporal data collected over a period of years. These data were obtained from the Nigerian NSO website as a PDF file and retyped in an Excel spreadsheet. The data originally contains the population data of the 37 states in the country and only data of two years i.e. 1999 and 2006 were found on the website. In order to obtain more temporal data, the researcher sent a mail to the Nigerian NSO website for more information on how to obtain more temporal data but was informed that the NSO website only have data for 1999 and 2006. Therefore, the intermediate years (2001, 2003 and 2005), are fictitious data added by the researcher to better able to demonstrate the functionality of the prototype. In order to upload the data into the CS4 Professional environment, an XML schema was created and then the data was converted into an XML file. ArcMap was used for the first stage of the data preparation. This software was used for geo-referencing and digitizing the base map. Then, the Excel spreadsheet was imported and joined to the attribute table, from which the maps were created before they were imported into the CS4 environment.

4.5. The Prototype

The prototype was developed using Flash CS4 Professional software and ArcMap. A base map for Nigeria was obtained from my organisation in Nigeria, digitized and geo-referenced in ArcMap. The generated map was then copied and pasted into Flash CS4 Professional as different layers and these layers were converted to movie clips, buttons or graphics. Using the action environment, codes were generated in action script programming language and added to the buttons and movie clips. These codes were used to automatically load the XML file containing the spatio-temporal statistical data, calculate the symbol sizes for the proportion symbol map from the data loaded and also compute and load the appropriate colours in the choropleth maps. The prototype basically focuses on the dissemination of spatio-temporal population data using animated and interactive proportional symbols, interactive choropleth, single static and multiple static maps. The prototype has three major pages which include the home (interface) page, spatio-temporal statistical data page and population database page. The population interface has defined links to the table, population density and absolute number of population interfaces. Although the overall concept proposed in the conceptual design was maintained in the actual prototype implementation, few changes were made in the prototype. For the interface of the prototype, the screen dump of the Nigerian NSO website was used as the interface of the prototype,

to create the impression of the real NSO website. Also, the data were stored as XML file instead of in a database, due to the simplicity and quantity of the data being used. Also, the

4.5.1. Prototype Interface

The interface for the prototype was created from the original Nigerian NSO website. To create this, a screen shot of the original NSO website was taken and edited using paint software. This was then saves as a "TIFF" file and imported into the CS4 Professional software. The imported file was converted into a movie clip and a button (spatio-temporal statistical data) was created to link this page to the prototype. The image of the interface of the prototype is shown below and a direct connection is made to the prototype.

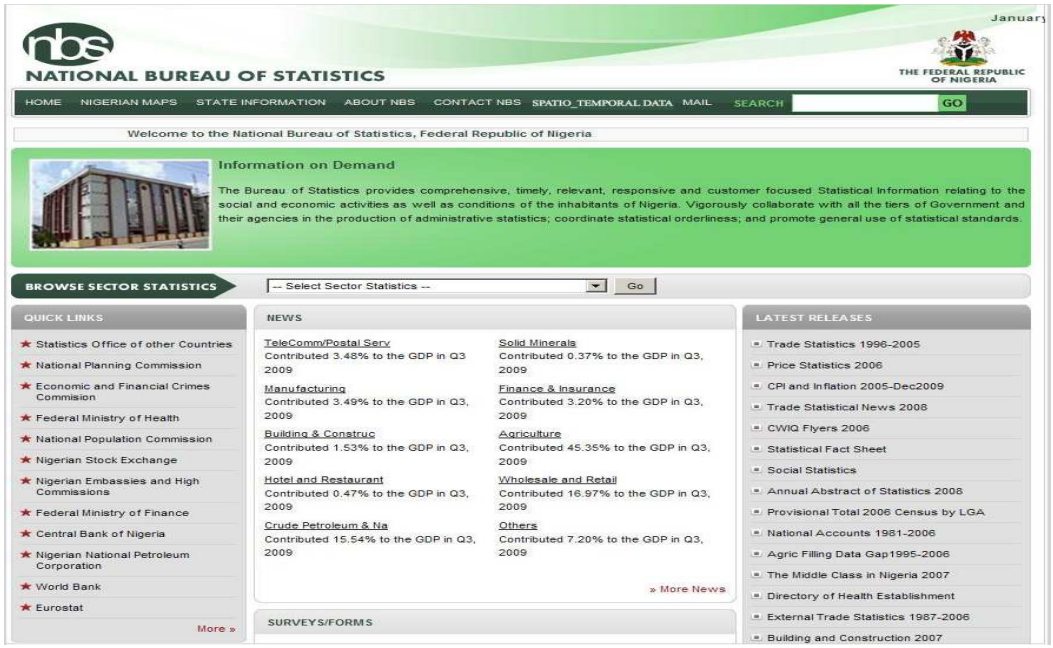


Figure 4-1: Homepage of the Nigerian NSO website with added button "Spatio-temporal Data" linking to the prototype

4.5.2. Interface for the Retrieval of the Spatio-Temporal Statistical Data

The spatio-temporal statistical database, like many other statistical database pages on many other websites, has the definition of spatio-temporal statistical data and also a list of all statistical data which is disseminated by subject area. The spatio-temporal statistical database was created from layers of movie clips and buttons. This page contains link to the population database. Although there are other options on the subject by area list, only the population option is activated in this prototype. This page also contains links which allows for navigation within the prototype.

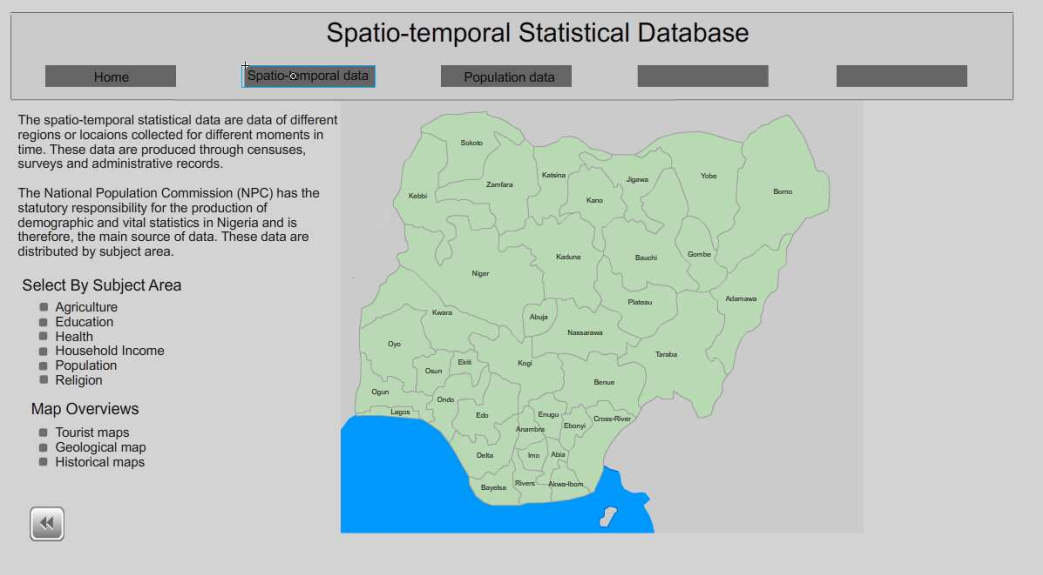


Figure 4-2: Interface for the retrieval of the Spatio-temporal statistical data on the prototype of the Nigerian NSO website

4.5.3. Population Page Interface

The population page was designed to serve as an interface that allows users to select the needed method of retrieval and visualization of spatio-temporal statistical data. It is the interface to the table and map pages. The page like all other pages on the prototype is a collection of movie clips and buttons. The image of the population database page is shown below in Figure 4-6.

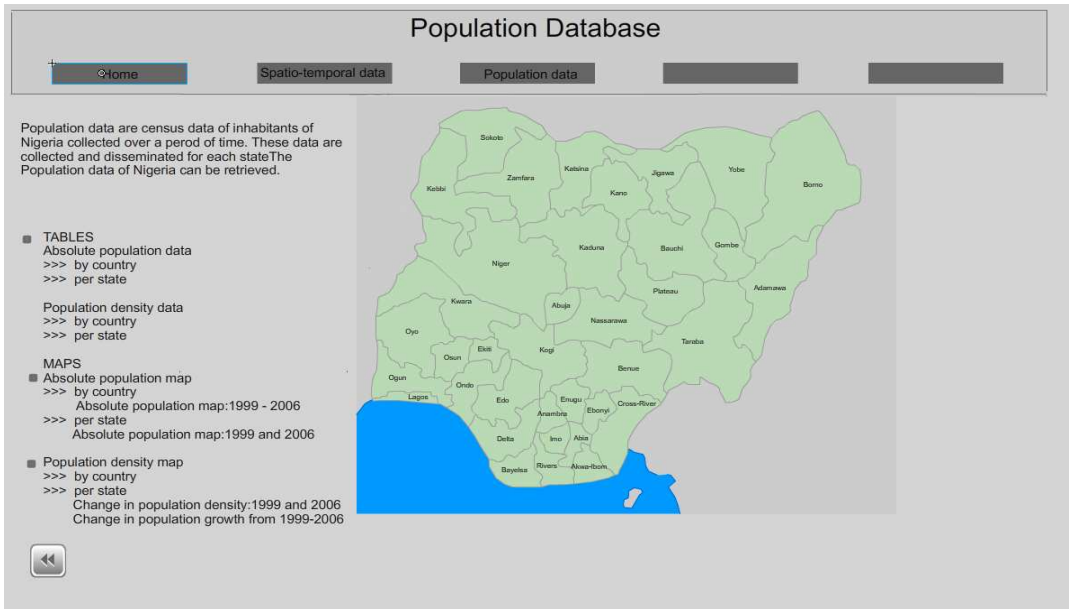


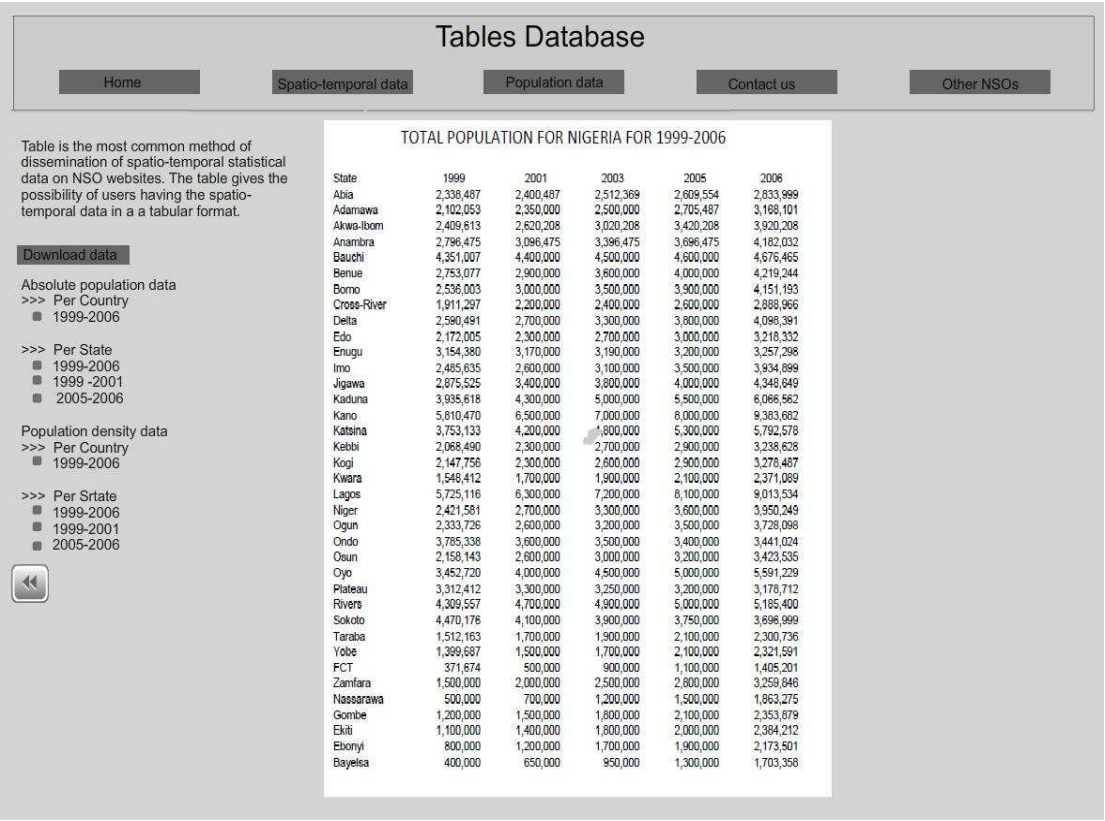
Figure 4-3: Population page interface of the developed prototype of the Nigerian NSO website

4.5.4. Retrieval and Visualization Methods in the Prototype

As earlier mentioned, the retrieval and visualization of spatio-temporal statistical data are disseminated on the prototype using the tables and maps. There are four types of maps in the prototype i.e. an animated proportional symbol map, an interactive choropleth map, single static and multiple static maps. Both the table and maps methods allow for the retrieval and visualization of spatio-temporal data for both population density and absolute population number data.

4.5.5. Tables

The table is one of the methods of data dissemination in the prototype. On the prototype, a table database was created to allow for both the retrieval of tables in the prototype. The tables are stored either as a population density data or as absolute number of inhabitant of an area over different moment in time. Based on the result of the prototype evaluation, the table in the prototype allows users to instantly visualize the data for both the population density of an area and the absolute number of population of inhabitants. The prototype also allows users to download spatio-temporal statistical data, see 4-7 below.



State	1999	2001	2003	2005	2006
Abia	2,338,487	2,400,487	2,512,369	2,609,554	2,833,999
Adamawa	2,102,053	2,350,000	2,500,000	2,705,487	3,168,101
Akwa-Ibom	2,409,613	2,620,208	3,020,208	3,420,208	3,920,208
Anambra	2,796,475	3,096,475	3,396,475	3,696,475	4,182,032
Bauchi	4,351,007	4,400,000	4,500,000	4,600,000	4,676,465
Benue	2,753,077	2,900,000	3,600,000	4,000,000	4,219,244
Borno	2,536,003	3,000,000	3,500,000	3,900,000	4,151,193
Cross-River	1,911,297	2,200,000	2,400,000	2,600,000	2,888,966
Delta	2,590,491	2,700,000	3,300,000	3,800,000	4,098,391
Edo	2,172,005	2,300,000	2,700,000	3,000,000	3,218,332
Enugu	3,154,380	3,170,000	3,190,000	3,200,000	3,257,298
Imo	2,485,635	2,600,000	3,100,000	3,500,000	3,934,899
Jigawa	2,875,525	3,400,000	3,800,000	4,000,000	4,348,649
Kaduna	3,935,618	4,300,000	5,000,000	5,500,000	6,066,562
Kano	5,810,470	6,500,000	7,000,000	8,000,000	9,383,682
Katsina	3,753,133	4,200,000	4,800,000	5,300,000	5,792,578
Kebbi	2,068,490	2,300,000	2,700,000	2,900,000	3,238,628
Kogi	2,147,756	2,300,000	2,600,000	2,900,000	3,278,487
Kwara	1,548,412	1,700,000	1,900,000	2,100,000	2,371,089
Lagos	5,725,116	6,300,000	7,200,000	8,100,000	9,013,534
Niger	2,421,581	2,700,000	3,300,000	3,600,000	3,950,249
Ogun	2,333,726	2,600,000	3,200,000	3,500,000	3,728,098
Ondo	3,785,338	3,600,000	3,500,000	3,400,000	3,441,024
Osun	2,158,143	2,600,000	3,000,000	3,200,000	3,423,535
Oyo	3,452,720	4,000,000	4,500,000	5,000,000	5,591,229
Plateau	3,312,412	3,300,000	3,250,000	3,200,000	3,178,712
Rivers	4,309,557	4,700,000	4,900,000	5,000,000	5,185,400
Sokoto	4,470,176	4,100,000	3,900,000	3,750,000	3,696,999
Taraba	1,512,163	1,700,000	1,900,000	2,100,000	2,300,736
Yobe	1,399,687	1,500,000	1,700,000	2,100,000	2,321,591
FCT	371,674	500,000	900,000	1,100,000	1,405,201
Zamfara	1,500,000	2,000,000	2,500,000	2,800,000	3,259,846
Nassarawa	500,000	700,000	1,200,000	1,500,000	1,863,275
Gombe	1,200,000	1,500,000	1,800,000	2,100,000	2,353,879
Ekiti	1,100,000	1,400,000	1,800,000	2,000,000	2,384,212
Ebonyi	800,000	1,200,000	1,700,000	1,900,000	2,173,501
Bayelsa	400,000	650,000	950,000	1,300,000	1,703,358

Figure 4-4: Table interface of the developed prototype of the Nigerian NSO website

4.5.6. Interactive Choropleth Map

Choropleth maps are maps in which mapped locations are shaded, patterned or coloured in proportion to statistical variable or data collected. The primary characteristic of a choropleth map is that it symbolizes the magnitudes of the statistics as they occur within the boundaries of the unit area using

colours (Goldsberry et al, 2009). An interactive choropleth map is a map that shows the change in spatio-temporal statistic of an area using increase or decrease in the colour value or colour shade and also have some interactive functionality for example, being able to retrieve the actual statistical data by just clicking on the map. By using the arrow buttons, it is possible to visualize the change in population distribution for different years. For the prototype, an interactive choropleth was developed. This gives the user the opportunity to extract population density data from the map for different geographic location for different years by clicking on the required map area. See Figure 4-8.

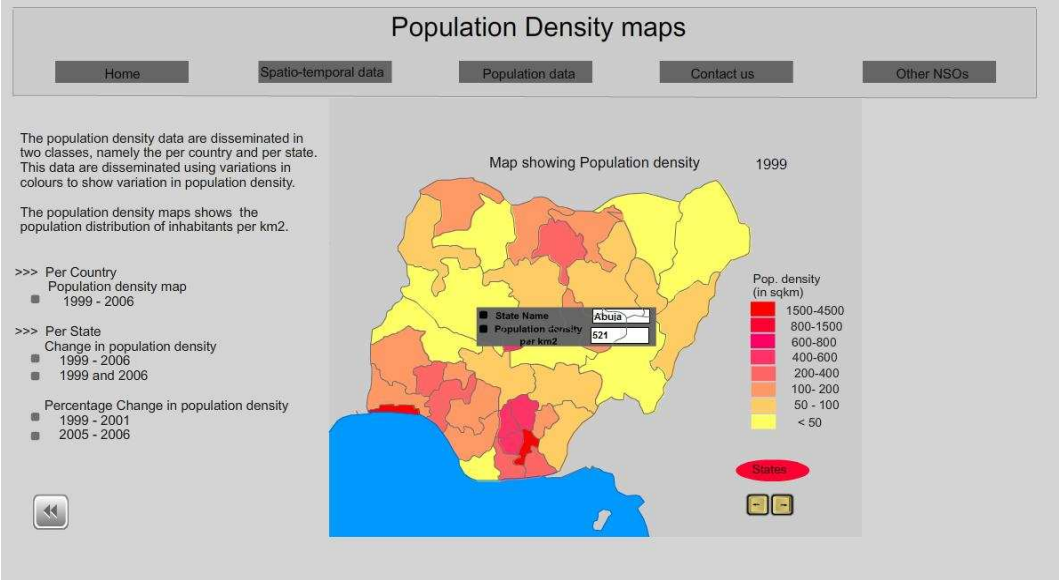


Figure 4-5: Interactive choropleth map for population distribution for 1999 to 2006

4.5.7. Animated Proportional Symbol Maps

A proportional symbol map is a map designed to disseminate data about a geographic location using symbols which are proportional to the data collected for that particular location. The use of symbol is one of six the graphic cartographic variables that were defined by Bertin (1983).The proportional symbol map uses differences in symbol sizes to depicts differences in the datasets from which these symbols are produced from. The use of proportional symbol map for showing absolute population growth is a very common phenomenon because users can easily interpret the bigger symbols to represent larger population growth than the smaller symbols. In the prototype, an animated proportional symbol map was developed that allows for users to see the gradual growth of the symbols according to the available data. This was based on the comments obtained from users during the requirement analysis testing concerning the ease of the use of animated maps for the retrieval of spatio-temporal statistical data. The map also offers the possibility of retrieving the actual data from the map through the pop-up window concept. See Figure 4-9 below.

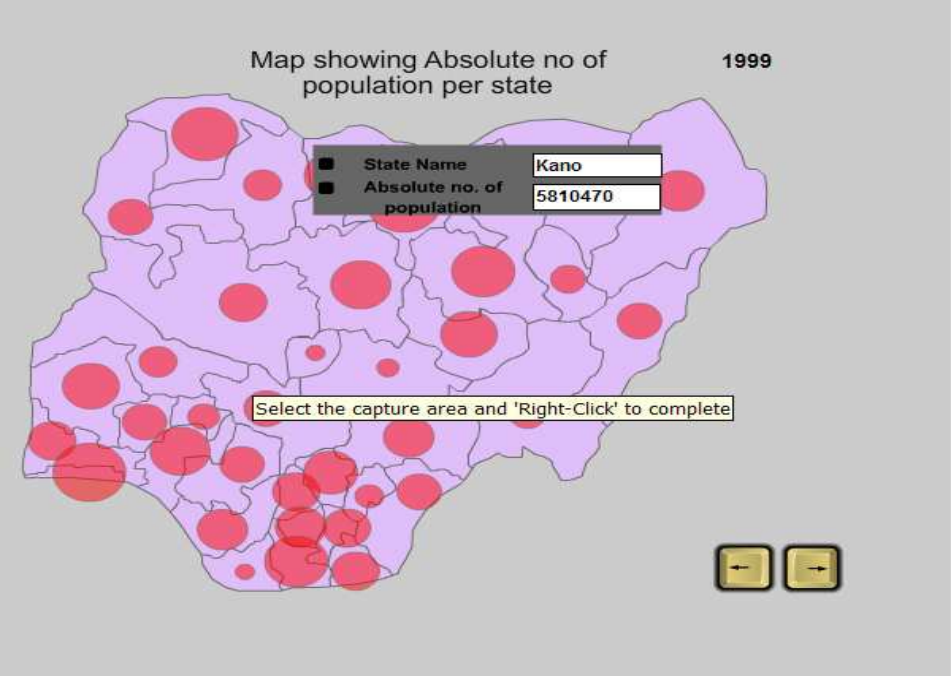


Figure 4-6: Animated proportional symbol map for population change from 1999 to 2006

4.5.8. Multiple Static Maps

Multiple static maps are maps that show two different time series maps as two separate maps. These maps as they are in the prototype are non-interactive maps and show information only about a particular time or event. For most multiple static maps, the use of colour or hue is mostly use for the dissemination of information and the variation of the colour or hue is dependent on the attribute that is been mapped. Based on the result of the requirement analysis usability testing conducted, it was observed that most of the test participants could not open the multiple windows together. Therefore, in the prototype, the multiple static maps for two different moments in time are presented side-by-side for easy retrieval and visualization by users. Figure 4-10 below shows the multiple static maps as can be found on the prototype.

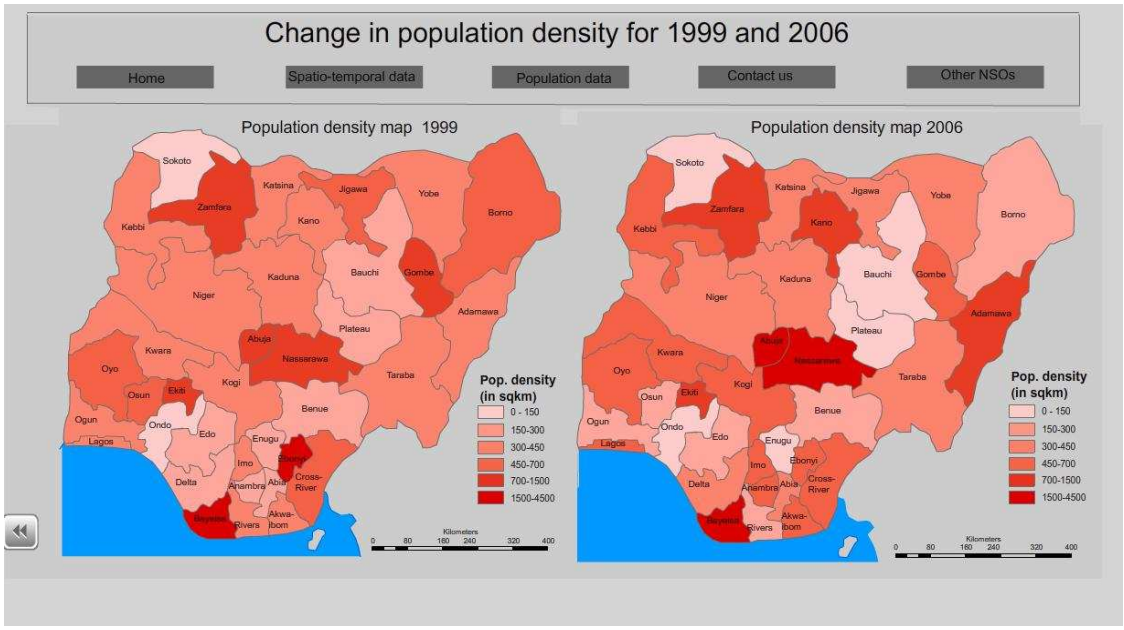


Figure 4-7: Multiple static maps for population density for 1999 and 2006

4.5.9. Single Static Maps

The single static map is another popular map used for the retrieval and visualization of spatio-temporal statistical data. This map, unlike the multiple static maps, shows changes that occurred in a phenomenon over different time sets. This simply means that the changes that occur between two different time sets can be portrayed using a single static map. In order to map using a single static map, the percentage of change between the two time sets of the phenomenon have to be calculated and this is mapped to obtain the single static map. Similarly to the multiple static maps, the single static map in the prototype is a non-interactive map.

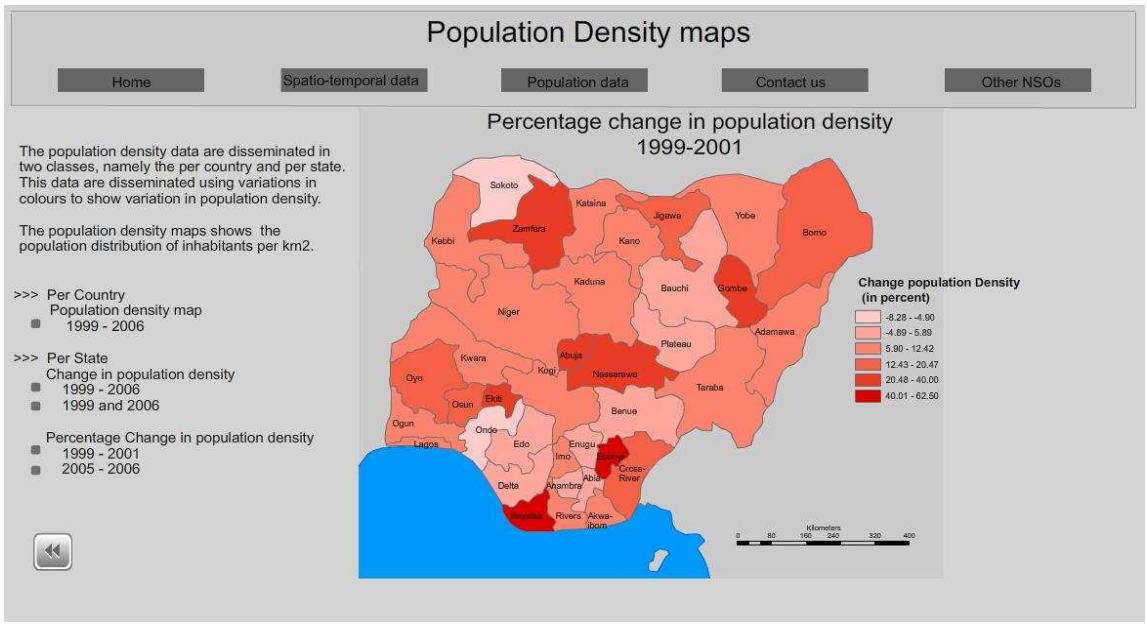


Figure 4-8: Single static map showing percentage change in population density for 1999 and 2006

4.6. Conclusion

Overall, the aim of conducting the requirement analysis testing was to obtain users requirements for the dissemination, retrieval and visualization of spatio-temporal statistical data and to develop an improved Nigerian NSO website prototype which is more effective, efficient and satisfactory from users' perspective. The prototype was developed based on the result of the requirement analysis testing and will be tested to see if the users' requirements are met.

5. Prototype Evaluation

5.1. Overview

This chapter deals with the evaluation of the Nigerian NSO website prototype, developed in the previous chapter. This prototype is evaluated through usability testing. The testing involves allowing test participants to execute some tasks based on defined scenarios using the prototype. The output of the test will be analyzed and compared with the results of the requirement analysis phase.

5.2. Usability Evaluation of Prototype

The prototype evaluation is the third and final phase of the UCD method. This phase deals with the evaluation of the prototype designed in the second phase. The prototype evaluation phase is another usability phase carried out to determine the effectiveness, efficiency and user satisfaction of the prototype in the dissemination, retrieval and visualization of spatio-temporal statistical data. In this research the case study is the developed prototype. The prototype evaluation is usually an iterative process between the prototype design phase and the prototype evaluation phase, see Figure 1-1. This usually involves the prototype testing with test participants repeatedly and applying corrections obtained from these testing sessions until the final output meet the users expected needs of the users.

According to Rubin et al (2008), a product (or prototype) should have the following characteristics and these characteristics will be tested in the prototype:
Efficiency: This refers to the quickness with which the users' goal can be accomplished accurately and completely and this is usually a measure of time.
Effectiveness: This refers to the extent to which the products behave in the way that users expect it to and the ease with which users can use it to do what they intend.
Satisfaction: This refers to the users' perceptions, feelings and opinions of the product in performing the required tasks.

5.2.1. Designing and Execution of the Prototype Evaluation Phase

As earlier mentioned, the aim of this evaluation was to determine how the prototype developed satisfies the users' needs for the retrieval and visualization of spatio-temporal data from the Nigerian NSO website and whether the prototype is effective, efficient and satisfactory to its users. This evaluation session was also used to test how users actually retrieve data from this part of the NSO website, what methods were used and why. For the design and execution of this evaluation session, a scenario was made (see Appendix 12).

In this evaluation session, the same techniques as used in the requirement analysis phase were applied. According to Nielsen (1994), the best result of any usability testing can be obtained by using combination of several usability techniques. Therefore, three techniques were adopted. These techniques include thinking aloud, a questionnaire and an interview. The questionnaire was divided into two parts. The first part was designed to gather information about the test participants, see Appendix 8. This questionnaire was very similar to the questionnaire used for the requirement analysis phase. The

second part of the questionnaire was designed based on the objectives of the evaluation session. This part included tasks and scenarios designed to collect information on the effectiveness, efficiency and satisfaction of the users in using the prototype. The questionnaire also includes questions used for monitoring and analyzing the various methods of retrieval and visualization techniques applied by the users for the various tasks. The users were expected to fill this second questionnaire the in combination with the thinking aloud while executing the tasks. A brief interview session was held at the end of each session, in order to investigate the level of tests participants' satisfaction in working with the prototype. The think aloud technique was used to record all the activities, which includes the filling of the questionnaires by the TPs, the task execution and the interview sessions, of all the test participants. The recorded output was later analyzed to extract needed information to determine the effectiveness, efficiency and satisfaction of users. Finally, an introductory note was designed to welcome all test participants and give a brief description of what the testing session involved. This included information on what was expected from each test participants, a brief description of the testing procedure and techniques, and the duration of the testing period. See appendix 11 for a copy of the introductory note. Test pilots were conducted using two students from GFM before the tests were actually carried out with the real test participants.

Below are some of the tasks carried out by test participants for the prototype evaluation.

- Suppose you want to know where most people live in the Northern part of Nigeria, by state distribution in 2 different years. Is it possible to find the state(s) with the largest number of inhabitants in the Northern part of Nigeria for the years 1999 and 2005?

- Let us consider population density now (number of inhabitants per km2). Are there differences in the changes of population density in the period 1999-2005 between different parts of the country?

- For 1999-2001 and 2005-2006, is it possible to determine percentage change in population density for states in the country?

5.2.2. Test Techniques for Evaluation Session

Think aloud method

This technique is a qualitative technique that involves the use of five to nine test participants. This test will be recorded both audio and video, and also screen logging. This technique was selected because it will allow the researcher to have the opportunity to watch the test participants perform the given tasks and also what is shown on their computer screen. It also allows for replay of the scenarios of the test as carried out by the test participants and also to determine the time taken for the execution of each tasks. The time taken to carry out each tasks and the completeness of the tasks can also be deduced from the recorded data. The think aloud also gives more opportunity of extracting information on how users executed the given tasks with the prototype, which might not have been possible with other techniques such as a focus group. The technique allows for comparing the users' activities with what users actually say during the execution of the tasks. Based on this, the effectiveness, and the efficiency of the prototype can be determined.

Questionnaire

The questionnaire is a technique which involves test participants filling out some predefined questions before (see Appendix 8) and during the testing session (sees Appendix 9). This technique was selected because it can easily be combined with the think aloud technique to collect useful information about test participants and tasks executed. The questionnaire (also called survey), can be used as a quantitative or qualitative technique. For this testing session, the first questionnaire will be used to collect simple background information about test participants and their knowledge and level of interaction with the Internet as a means of retrieving and visualizing information and most importantly, statistical information. The second questionnaire was used during the execution of the tasks. Test participants were be expected to fill in some answers related to their tasks directly into the questionnaires.

Interview

This is a technique that involves asking users questions relating to the task just completed. There are predefined questions for the test participants (see Appendix 10). This will be used to determine the users' satisfaction with the prototype. The interview session allows test participants to comment on some of the difficulties observed during the testing session and also to express their opinions of the whole test session.

5.2.3. Test Environments and Equipments for Evaluation Session

The test session was carried out in the usability laboratory on the first floor of the ITC building. This laboratory, which was set up in the year 2000 is equipped with a professional analogue SVHS video camera, for making the video recordings of the sessions and external microphones, to improve the sound system. The laboratory also has a computer system, for test participants to carry out the required tasks. Finally, the room is also fitted with a digital quad unit, which allows for the synchronization of the video signals of the test participants, a screen logging from the computer monitor and audio signals and all can be seen together on a television screen (see Figure 3-13) and a video recorder player to analyze the output of the testing session. The recording devices are needed not only for analysis purposes, but they also provide a scientific proof of what actually occurred during each test session.

5.2.4. Test Participants for Evaluation Session

According to Rubin et.al (2008), a minimum of four to five test participants is needed to expose as many usability problems as possible in a short time and also to determine the effectiveness and efficiency of the product. In selecting the number of test participants, certain factors had to be considered: the number of available resources to set up and conduct the test, the types of test participants required and the duration of the test. It is important to balance the number of test participants with practical constraints of time (Rubin et al, 2008).

For this testing session, seven ITC students from various departments were used as test participants and these test participants were classified into two groups. The first group of test participants consisted of students with little knowledge of maps for retrieval and visualization purposes. The second group of test participants included students with knowledge of maps; either had used maps for retrieval and visualization of data or had worked with maps for other analysis purposes. Both groups of test

participants were selected after a short verbal interview with the researcher. The major reason for this distinction was to compare the methods and approaches taken by the two groups of test participants in the retrieval and visualization of spatio-temporal statistical data.

5.2.5. Conducting the Prototype Evaluation Session

The prototype evaluation session was divided into two major parts. The first part, like the requirement analysis testing, started with the researcher welcoming the test participants. This was carried out by the researcher reading the introductory note out to the test participants while they read along from copies given to them, (see Appendix 11).The welcoming note included a welcoming statement and an expression of the researcher's appreciation for the test participants' positive response to being part of the prototype evaluation sessions. It stated the research topic and explained the aim of the research. It also explained the purpose of carrying out the testing session, which was basically to evaluate the effectiveness and efficiency of the developed prototype and also users' satisfaction. The evaluation session was also used to determine the various ways and methods in which users retrieve and visualize spatio-temporal statistical data. The introductory note briefly described the techniques used for the evaluation session and test participants were asked to be time conscious, and were also encouraged to relax during the process of carrying out their tasks. The note also included information about how the test would be conducted and the estimated time needed for the tasks.

The aim of the introductory note was to ensure uniformity and exactness in the information given to all test participants. This was also to stress the importance of thinking aloud during the execution of the tasks to the test participants. The test participants were then shown the test equipment.

Following the reading of the introductory note, test participants were given the first questionnaire and were asked to think aloud while filling the questionnaire. This was to help test participants have the feel of the think aloud technique and also an opportunity for the researcher to stress the importance of the technique to the test participants, while at the same time opening the prototype. Having filled the questionnaire, the task sheet (see Appendix 9), was given to the test participants and they were left to carry out the tasks without supervision. Test participants were asked to write some simple answers into the task sheet given to them and also to think aloud through out the process of the tasks execution.

On completion of the tasks, which was estimated to last about 20-25 minutes per test participants, a short interview was conducted for each test participants. The interview started with some predefined questions (see appendix 10), and also additional questions were asked based on comments made by test participants either in the filled questionnaire or during the execution of the tasks. The interview session lasted for duration of 10 minutes per test participant. The evaluation sessions were executed during three days and seven test participants were tested.

5.3. Outcome of the Prototype Evaluation

Using the three phases of analysis as recommended by Rubin et al (2008) and used in the requirement analysis testing, all data collected during this evaluation session were analyzed as described below:

- Transcribing and data summarization
- Data analysis
- Results

5.3.1. Transcribing and Data Summarization

All video, audio and screen logging recordings were compiled and transcribed by the researcher at the end of each day of the test. This involved the process of writing out all the recorded information in tabular format. This was to allow for easy identification of data collected per test participants' and to find correlations and patterns, in comments made by test participants and methods used in solving the tasks, from the evaluation session. This process was carried out daily to help speed up the overall analysis process and also to ensure that the needed information that answered the defined objectives of the test was collected.

The video and audio recordings of the whole testing session were first transcribed directly as it was recorded into texts and summarized by the researcher into a tabular format according to each task. Some important comments from test participants for each individual task were also added. Ratings, time taken for completing the task and tools applied for solving each tasks were also recorded. The summaries were then further summarized into a more concise and short statement. This was done for easy analysis of test participants' responses and for identifying patterns and similarity between statements made by test participants for each task. These data were compiled and summarized into different categories for easy data extraction. For all transcribed materials, summary tables and extracted tables: see Appendix 13.

5.3.2. Data Analysis

In order to analyze the data, the information from the two groups was analyzed separately. The Group 1 represents users with little knowledge of maps for retrieval and visualization of data while the Group 2 consists of users with knowledge of maps for retrieval and visualization of data. From the data collected from the two groups of test participants, the effectiveness, efficiency and users' satisfaction of the prototype were analyzed. Group 1 consists of 3 TPs while Group 2 consists of 4 test participants. By analyzing the output of the questionnaire from the evaluation session, it was observed that although the majority of the total test participants understood what statistical data are, only three TPs have used it for any work purpose. Based on the output of the evaluation session, no real differences were observed in the performances of these two groups.

For the proportional symbol maps, most test participants commented on the ease of retrieving information from the maps and also commented on how useful it was to identify changes in population distribution of different regions for different years by just looking at the changes in the symbol sizes. TP 6 commented, "It was very easy to see the largest growing population in the north" and TP 1 also commented that, "This is good. I can see the largest state immediately"

The interactive choropleth map alone was used to answer various questions related to population density for different regions and different years although some test participants such as TP 4 and TP 5 combined the interactive choropleth map with multiple static maps and tables. Most TPs commented that "it is possible to see that there are many changes in the North and south region of the country than other parts of the country" and others commented on the possibilities of seeing changes in the population density over different regions for different years. "I am able to see the changes that are occurring in the population density for various parts of the country".

The multiple static maps were used by three test participants for questions two and three in combination with the choropleth map while the single static maps were used by all test participants to solve question four. All test participants commented on the ease of determining the regional differences in population density for two different years. For example, TP 7 commented that "the changes were clear to identify" and TP 6 commented "I can see differences in the two years for different part of the country by looking at the map and using the legend".

Efficiency

In order to determine the overall efficiency of the prototype, all tasks were timed and checked for correctness. All tasks were given an estimated time of four minutes for completion and with definite answers, such as the name(s) of the largest state in the Northern part of Nigeria can easily be retrieved and checked. The evaluation output shows that all tasks were completed successfully and even much faster than the specified estimated time, which was 4 minutes. In order to calculate the efficiency of the prototype, the mean time and the numbers of successful completion of each given task were determined. Figure 5-1 below shows charts of the time taken to complete each task and the number of TPs that were able to complete each task successfully.

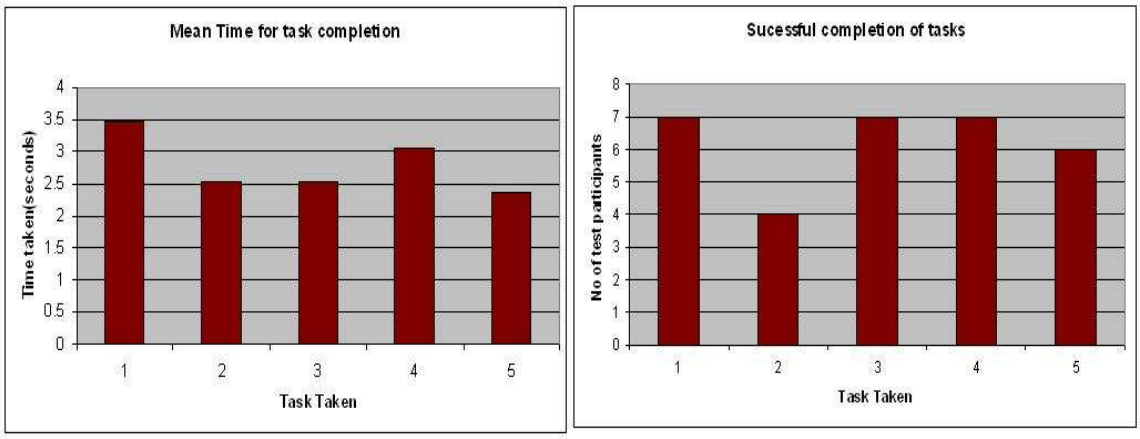


Figure 5-1: Bar charts showing the efficiency of the prototype

Effectiveness

As defined earlier, effectiveness is the extent to which the products behave in the way that users expect it to and the ease with which users can use it to do what they intend. In order to determine the effectiveness of the prototype, tasks were given to the users to enable them to retrieve and visualize spatio-temporal statistical data. The tasks (see section 5.2.1) included determining regional population changes and distributions over different years. For an effectively execution of these tasks as obtained from the requirement analysis testing, users expect maps and these maps should be interactive, animated and with well defined legends. In the evaluation session, most users in answering the given tasks directly navigate to the maps. The TPs commented on the ease of determining the regional changes over different years with the use of maps. TPs commented on the effectiveness of the interactivity and animation of the maps available in the prototype for quick and easy retrieval of the actual data from which the maps were produced and direct visualization of the changes. For instance,

TP 2 commented, “you can see changes in the colours as the year’s changes and by clicking the map, you see different data”, while TP 7 commented that “the changes were clear to identify”.

In general, all test participants rated the prototype as a very effective tool for the dissemination, retrieval and visualization of spatio-temporal statistical data.

Satisfaction

This refers to the users’ perceptions, feelings and opinions of the prototype in performing the required tasks. In the evaluation session, the users’ satisfaction of the prototype was determined and investigated using the interview technique. Here, users were asked predefined questions such as their level of satisfaction with the methods of retrieval and visualization as could be obtained with the prototype. All users were commenting on how satisfied they were with the methods available in the prototype. TP 2 commented that “with my knowledge of maps and website for data I have come across, this is the most user-friendly because what you need you get and the links are clear”. Also, TP 5 commented, “it is very satisfactory and I can use it for my research or work purpose. This is because I can easily get the information that I need” and still to add, TP 6 stated “I am satisfied with the prototype because of the easy navigation on the prototype to the different methods and the interactivity of the maps”. Although test participant 4 gave comments on how the interface might still be improved, all users gave satisfactory comments concerning the prototype and rated their levels of satisfaction either very satisfactory or satisfactory. The satisfactory level of users is shown in Figure 5-3 below.

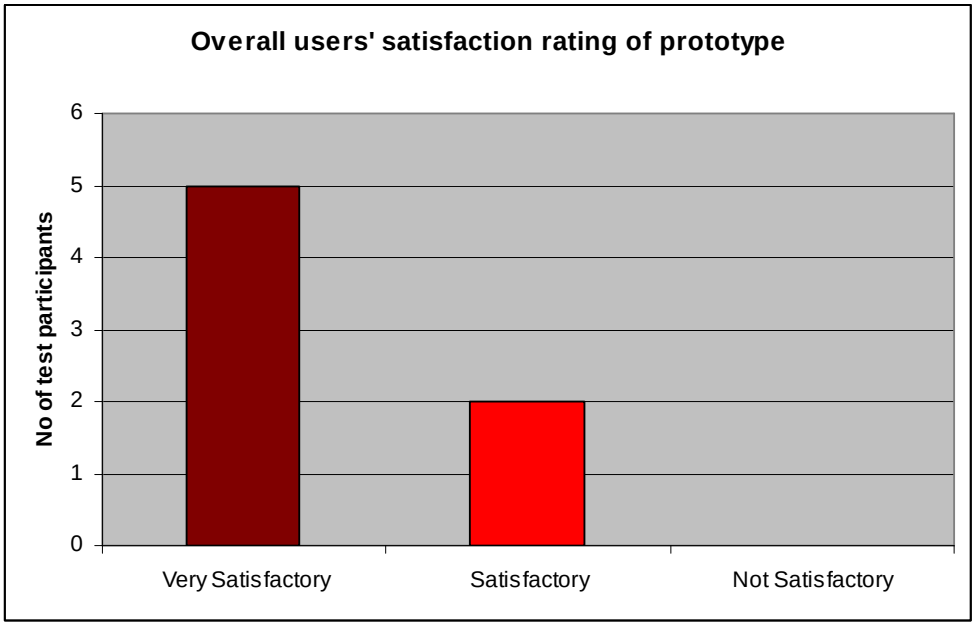


Figure 5-2: Bar chart showing test participants’ satisfaction rating of the prototype.

5.3.3. Results

In the analysis of the prototype evaluation, the three keywords of usability, i.e. effectiveness, efficiency and satisfaction, were investigated. The overall result focused on the efficiency, effectiveness and

users satisfaction in using the developed prototype for retrieval and visualization of spatio-temporal statistical data on NSO websites.

From the results obtained from the analysis, all test participants commented on the easy of navigating through the prototype interface for retrieval of the needed information to execute the given tasks. It was also observed, from both the comments of test participants and the execution of the tasks, that most users found the prototype efficient and effective for the retrieval and mostly visualization of spatio-temporal statistical data. All test participants were able to navigate easily to the population database from the home page and were able to select the necessary methods for carrying out the tasks, no instruction or assistance was required from the researcher. Most users were able to complete the given tasks correctly and within the estimated given time. Based on the interview output, users' responses relating to the level of satisfaction were determined. From comments obtained from test participants, the majority of test participants commented that they were very satisfied with using the prototype for the retrieval and visualization of spatio-temporal statistical data on NSO websites.

5.4. Conclusion

In summary, it is very obvious that the three keywords, i.e. effectiveness, efficiency and satisfaction, of a user centered design are met by the prototype for the dissemination, retrieval and visualization of temporal statistical data from the users' perspective. Overall users' needs relating to dissemination, retrieval and visualization of spatio-temporal statistical data on NSO website were met by the developed prototype.

6. Conclusions and Recommendations

6.1. Conclusions

For every user centered design, the product (or prototype) must be effective, efficient and satisfactory from the users' point of view. The main objective of this research was to contribute to the improvement of the dissemination, retrieval and visualization of spatio-temporal statistical data through national statistical websites from the users' perspective, using the Nigerian NSO website as a case study. In order to achieve this objective, the different methods of retrieval and visualization currently available on existing NSO websites were investigated through updating the data on the NSO switchboard. Then, by selecting two NSO websites, including the Nigerian NSO website, a user requirement analysis testing was conducted, and an improved prototype was designed and evaluated.

Based on the requirement analysis testing, the effectiveness, efficiency and users satisfaction of the different retrieval and visualization methods available on existing NSO websites were investigated, using Nigerian and Swedish NSO websites as case studies. The ease of retrieving data from these case studies was investigated. From the interfaces of the selected NSO websites, it was observed that users were not easily able to locate the required data, although the Swedish NSO website interface proved to be more user-friendly than the Nigerian NSO website interface. Secondly, the retrieval and visualization of spatio-temporal statistical data were also investigated. The results showed that majority of the test participants were not able to retrieve the data required for carrying out the given tasks easily and without instructions from the researcher. The methods of visualization available on the websites, such as tables, multiple and single static maps were not easily understood by TPs based on poor cartographic variables and complex legends used on the maps. Thirdly, it was difficult for test participants to compare two maps of different years based on the inability of opening the multiple windows view on the Swedish NSO website. From the results, it was observed that users found the use of interactive and animated maps very useful for retrieval and visualization of data along with single and multiple static maps. Also, tables were recommended for storage and retrieval of data for analysis but not for visualization purposes.

Taken all the above information into consideration, a prototype was developed and through evaluation, the efficiency, effectiveness and users' satisfaction of the prototype was determined. The prototype included tables and maps and the maps were divided into two categories (based on subject represented): the absolute population map (animated proportional symbol map) and the population density maps. In terms of methods of dissemination, the prototype also included tables, a single static map, multiple static maps, an interactive choropleth map and an animated map. The maps were developed using proper cartographic variables and well defined legends. Also, a more user-friendly interface was built, taken into consideration the definitions of the data stored and simple retrieval methods.

The output of the prototype was a great improvement to the current methods in which spatio-temporal statistical data are currently being disseminated on the Nigerian NSO website. On the Nigerian NSO website, data are disseminated and retrieved only in the form of a PDF document and these data can only be visualized through charts in a static form. Currently, no map is offered on the website for

retrieval and visualization of either statistical or spatio-temporal statistical data and users do not have the opportunity of selecting their preferred methods for executing their tasks on the NSO website. The prototype offers the users different types of maps (animated, interactive and static) for execution of different types of tasks depending on the data needed. The users have the option of selecting the years required and also the possibility of retrieving the actual figure in which the map was produced from. The prototype also allows the users the opportunity of downloading the data in an excel format for further analysis if required by the users. In the prototype, unlike the existing multiple static maps which was found on the Swedish NSO website, the interface of multiple static maps was designed to allow for upload of two maps of two different years, such that both maps are placed side by side. This was done to enhance the easy of comparing of two maps of two different years. This interface proved to be very effective for retrieval and visualization of two moments in time. An animated proportional symbol map was developed to disseminate the absolute population data. This map was made both animated and interactive. The map allow users to retrieve data by simply clicking on the proportional symbol, while the differences in the symbol sizes give the required visual information on the distribution of the spatio-temporal statistical data. Another map that can be found in the prototype is the interactive choropleth map. This map was used to disseminate information relating to the population density distribution. The variation of colours shows the differences in population density of different regions for different years, while by clicking on the map it is possible to retrieve the actual population data. The simplicity of the interface and maps made it possible for users, with and without knowledge of maps, to easily retrieve and visualize spatio-temporal statistical data from the prototype.

In conclusion, the main objective of this research, which was to improve methods of dissemination, retrieval and visualization of spatio-temporal statistical data on NSO websites, was achieved through the developed prototype and based on the evaluation, the prototype was found to be effective, efficient and meets users' satisfaction.

6.2. Recommendations

Based on the result obtained from the requirement analysis, a conceptual design was designed, which included the data to be stored in a database. This was to allow the users the possibility of selecting the different years for which they wish to investigate. However, because of time constraints, in this research the spatio-temporal statistical data were stored using a simple XML file and this format does not allow querying. As an improvement to this prototype, it is recommended that a database is developed for storing the attribute, temporal and geometry data for each state or province. This would allow for the possibility of querying for specific locations and time without getting the whole country map, when necessary. This will also allow for an easy update of data. Also, more functionality, such as simple querying possibilities and an option for selecting the required years should be added to the prototype, while at the same time keeping the interface as simple as possible.

Although animated proportional symbol and choropleth maps were developed in this research, for further research, it is suggested that different animations should be developed and combined for the retrieval and visualization of spatio-temporal statistical data on NSO websites from the users' perspective and these animations should be evaluated using usability techniques. The recommended research would be to determine how users respond to different animations used in the dissemination,

retrieval and visualization of spatio-temporal statistical data through NSO websites. This research would also help to determine the most effective and efficient animation or combination of animations for the dissemination, retrieval and visualization of spatio-temporal statistical data.

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URL3. ITC kartoweb/nso Retrieved 16 September, 2009, from http://kartoweb.itc.nl/nso/
URL4. UN Statistic Division. Retrieved 160 September, 2009, from <http://unstats.un.org/unsd/methods/inter-natlinks/sd_natstat.asp>.
URL5. U.S Census Bureau Retrieved 16 September, 2009, from <http://www.census.gov/aboutus/stat_int.html>
URL6. EDIRC of the University of Connecticut Retrieved 16 September, 2009, from http://edirc.repec.org/statoff.html
URL7. Statistic Norway Retrieved 16 September, 2009, from http://www.ssb.no/en/links/
URL8. Czech Republic NSO. Retrieved 8 October, 2009, from http://www.czso.cz/
URL9. Iceland NSO. Retrieved 8 October, 2009, from http://www.hagstofa.is/
URL10. Australia NSO. Retrieved 8 October, 2009, from http://www.abs.gov.au/
URL11. Andorra NSO. Retrieved 8 October, 2009, from http://www.estadistica.ad/serveiestudis/web/index.asp
URL13. Bangladesh NSO. Retrieved 8 October, 2009, from http://www.bbs.gov.bd/
URL14. Chile NSO. Retrieved 8 October, 2009, from http://www.ine.cl/canales/chile_estadistico/home.php
URL15. Brazil NSO. Retrieved 8 October, 2009, from http://www.ibge.gov.br/home/
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URL17. Sweden Statistical office. Retrieved 8 January, 2010, from <http://www.scb.se/default_2154.aspx>
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Appendix 1

Countries	NSO WEBSITES URLS
Afghanistan	www.aims.org.af/cso
Åland	http://www.asub.ax/
Albania	http://www.instat.gov.al/
Algeria	http://www.ons.dz/
Andorra	http://www.estadistica.ad/serveiestudis/web/index.asp
Antigua and Barbuda	http://www.ab.gov.ag/gov_v2/government/statsandreports/index.html
Anguilla	http://www.gov.ai/statistics/
Argentina	http://www.indec.mecon.ar/
Armenia	http://www.armstat.am/en/
Aruba	http://www.aruba.com/
Australia	http://www.abs.gov.au/
Austria	http://www.statistik.at/web_en/
Azerbaijan	http://www.azstat.org/indexen.php
Azores Islands	
Bahamas	http://statistics.bahamas.gov.bs/
Bahrain	www.inec.gob.ni
Bangladesh	http://www.bbs.gov.bd/
Barbados	http://www.barstats.gov.bb/
Belarus	http://www.belstat.gov.by/homep/en/main.html
Belgium	http://statbel.fgov.be/
Belize	http://www.statisticsbelize.org.bz/dms20uc/Main.asp
Benin	http://www.insae-bj.org/
Bermuda	http://www.seaexpress.bm/portal/server.pt?open=512&objID=227&mode=2&in_hi_userid=2&cached=true
Bhutan	http://www.nsb.gov.bt/index.jsp
Bolivia	http://www.ine.gov.bo/default.aspx
Bosnia and Herzegovina	http://www.bhas.ba/new/
Botswana	http://www.cso.gov.bw/
Brazil	http://www.ibge.gov.br/english/default.php#sub_populacao
Brunei Darussalam	http://www.jpm.gov.bn/
Bulgaria	http://www.nsi.bg/
Burkina Faso	http://www.insd.bf/
Burundi	http://burundistats.org/
Cambodia	http://www.nis.gov.kh/
Cameroun	http://www.statistics-cameroon.org/
Canada	http://www.statcan.gc.ca/
Cape Verde	http://www.ine.cv/
Central African Repubic	http://www.stat-centrafrique.com/
Chad	http://www.inseed-tchad.org/

Chile	http://www.ine.cl/canales/chile_estadistico/home.php
China	http://www.stats.gov.cn/english/index.htm
Colombia	http://www.dane.gov.co/
Congo	http://www.cnsee.org/index.htm
Cook Island	http://www.stats.gov.ck/
Costa Rica	http://www.inec.go.cr/
Cote d'Ivoire	http://www.ins.ci/
Croatia	http://www.dzs.hr/
Cuba	http://www.one.cu/
Cyprus	http://www.mof.gov.cy/mof/cystat/statistics.nsf/index_en/index_en?OpenDocument
Czech Republic	http://www.census.gov/aboutus/stat_int.html
Denmark	http://www.dst.dk/HomeUK.aspx
Djibouti	http://www.ministere-finances.dj/
Dominican Republic	http://www.one.gob.do/
Ecuador	http://www.inec.gov.ec/web/guest/inicio
Egypt	http://www.capmas.gov.eg/
El Salvador	http://www.minec.gob.sv/
Equatorial Guinea	http://www.dgecnstat-ge.org/
Estonia	http://www.stat.ee/censuses
Ethiopia	http://www.csa.gov.et/
Faroe Islands	http://www.hagstova.fo/portal/page/portal/HAGSTOVAN/Hagstova_Foroya
Fiji	http://www.statsfiji.gov.fj/
Finland	http://www.stat.fi/index_en.html
France	http://www.ined.fr/en/homepage_of_ined_website/
French Polynesia	http://www.ispf.pf/ISPF/Home.aspx
Gabon	
Gambia	http://www.gambia.gm/Statistics/index.htm
Georgia	http://www.statistics.ge/
Germany	http://www.destatis.de/jetspeed/portal/cms/
Ghana	http://www.statsghana.gov.gh/
Gibraltar	http://www.gibraltar.gov.gi/
Greece	http://www.statistics.gr/portal/page/portal/ESYE
Greenland	http://www.stat.gl/
Guam	http://www.spc.int/prism/country/gu/stats/
Guatemala	http://www.ine.gob.gt/
Guernsey	http://www.gov.gg/ccm/navigation/government/facts---figures/
Guinea	http://www.stat-guinee.org/
Guinea-Bissau	http://www.stat-guinebissau.com/
Honduras	http://www.ine-hn.org/
Hong Kong	http://www.info.gov.hk/censtatd/
Hungary	http://portal.ksh.hu/portal/page?_pageid=38,119919&_dad=portal&_schema=PORTAL
Iceland	http://www.statice.is/
India	http://www.censusindia.net/

Indonesia	http://www.bps.go.id/
Iran	http://www.sci.org.ir/portal/faces/public/sci_en
Ireland	http://www.cso.ie/
Isle of Man	http://www.gov.im/treasury/economic/census/welcome.xml
Israel	http://www1.cbs.gov.il/reader/cw_usr_view_Folder?ID=141
Italy	http://www.istat.it/english/
Jamaica	http://statinja.gov.jm/
Japan	http://www.stat.go.jp/english/index.htm
Jersey	http://www.gov.je/ChiefMinister/Statistics/
Jordan	http://www.dos.gov.jo/dos_home_a/main/index.htm
Kazakhstan	http://www.stat.kz/Pages/default.aspx
Kenya	http://www.cbs.go.ke/
Kiribati	http://www.spc.int/prism/Country/KI/Stats/
Korea	http://kostat.go.kr/nso_main/nsoMainAction.do?method=main&catgrp=nso2009
Kuwait	
Kyrgyzstan	http://www.stat.kg/
Latvia	http://www.csb.lv/avidus.cfm
Lebanon	http://www.cas.gov.lb/
Lesotho	http://www.bos.gov.ls/
Lebanon	http://www.cas.gov.lb/
Liechtenstein	http://www.llv.li/amtstellen/amt_fuer_volkswirtschaft/llv-avw-home.htm
Lithuania	http://www.stat.gov.lt/en/?PHPSESSID=ba7d3519a8d80213e922867f2c0fda69
Luxembourg	http://www.statec.public.lu/fr/index.html
Macau	http://www.dsec.gov.mo/default.aspx
Macedonia	http://www.stat.gov.mk/english/glavna_eng.asp
Madagascar	http://www.instat.mg/
Madeira	
Malawi	http://www.nso.malawi.net/
Malaysia	http://www.statistics.gov.my/eng/
Maldives	http://planning.gov.mv/en/
Mali	www.dnsi.gov.ml;
Malta	http://www.nso.gov.mt/site/page.aspx
Marshall Islands	http://www.spc.int/prism/country/mh/stats/Index.htm
Mauritania	http://www.ons.mr/
Mauritius	http://www.gov.mu/portal/site/cso/
Mexico	http://www.inegi.org.mx/inegi/default.aspx
Micronesia	http://www.spc.int/prism/country/fm/stats/
Moldova	http://www.statistica.md/?lang=en
Monaco	http://www.gouv.mc/devwww/wwwnew.nsf/HomeGb
Mongolia	http://www.nso.mn/v3/index.php#
Morocco	http://www.hcp.ma/
Mozambique	http://www.ine.gov.mz/Ingles
Myanmar	www.myanmar.com/Ministry/imm&popu/population/default.htm

Namibia	http://www.npc.gov.na/cbs/index.htm
Nauru	http://www.spc.int/prism/country/nr/stats/
Nepal	http://www.cbs.gov.np/
Netherlands	http://www.cbs.nl/en-GB/menu/home/default.htm
Netherlands Antilles	http://www.cbs.an/
New Caledonia	http://www.isee.nc/
New Zealand	http://www.stats.govt.nz/
Nicaragua	www.inec.gob.ni
Niger	http://www.stat-niger.org/
Nigeria	http://www.nigerianstat.gov.ng/
Niue	http://www.spc.int/prism/Country/NU/stats/
Norfolk Island	http://www.norfolk.gov.nf/
Northern Ireland	
Norway	http://www.ssb.no/english/
Oman	http://www.mone.gov.om/index.asp
Pakistan	http://www.statpak.gov.pk/
Palestinian Authority	http://pcbs.gov.ps/
Panama	http://www.contraloria.gob.pa/
Papua New Guinea	http://www.spc.int/prism/country/pg/stats/
Paraguay	http://www.dgeec.gov.py/
Peru	http://www.inei.gob.pe/
Philippines	http://www.census.gov.ph/
Poland	http://www.stat.gov.pl/gus/index_ENG_HTML.htm
Portugal	http://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_main
Qatar	http://www.qsa.gov.qa/eng/
Romania	http://www.insse.ro/cms/rw/pages/index.ro.do
Russia	http://www.gks.ru/eng/
Rwanda	http://www.statistics.gov.rw/
Saint Lucia	http://www.stats.gov.lc/
Samoa	http://www.spc.int/prism/Country/WS/stats/
Sao Tome and Principe	http://www.ine.st/
Saudi Arabia	http://www.cdsi.gov.sa/showsection.aspx?lid=26&id=162
Scotland	NEW website: www.gro-scotland.gov.uk/statistics/census/censushm/index.html
Senegal	http://www.ansd.sn/
Serbia and Montenegro	http://webrzs.statserb.sr.gov.yu/axd/en/index.php
Seychelles	http://www.nsb.gov.sc/
Sierra Leone	http://www.statistics.sl/
Singapore	http://www.singstat.gov.sg/
Slovakia	http://portal.statistics.sk/showdoc.do?docid=359
Slovenia	http://www.stat.si/eng/index.asp
Solomon Islands	http://www.spc.int/prism/country/sb/stats/
South Africa	http://www.statssa.gov.za/
South Korea	

Spain	http://www.ine.es/welcoing.htm
Sri Lanka	http://www.statistics.gov.lk/
Sudan	http://cbs.gov.sd/
Suriname	http://www.statistics-suriname.org/
Swaziland	http://www.gov.sz/
Sweden	http://www.scb.se/default____2154.aspx
Switzerland	http://www.bfs.admin.ch/bfs/portal/en/index.html
Tadjikistan	http://www.stat.tj/english/home.htm
Taiwan	http://eng.dgbas.gov.tw/mp.asp?mp=2
United Republic of Tanzania	http://www.tanzania.go.tz/statistics.html#top
Thailand	http://web.nso.go.th/eng/
Tokelau	http://www.spc.int/prism/country/tk/stats/
Togo	
Tonga	http://www.spc.int/prism/Country/TO/stats/
Trinidad and Tobago	http://www.cso.gov.tt/
Tunisia	http://www.ins.nat.tn/indexen.php
Turkey	http://www.turkstat.gov.tr/Start.do
Tuvalu	http://www.spc.int/prism/country/tv/stats/
Uganda	http://www.ubos.org/
Ukraine	http://www.ukrstat.gov.ua/
United Arab Emirates	http://www.economy.ae/English/Pages/default.aspx
United Kingdom	http://www.statistics.gov.uk/hub/index.html
United States of America	http://www.census.gov/
Uruguay	http://www.ine.gub.uy/#
Uzbekistan	http://www.stat.uz/STAT/index.php?lng=1
Vanuatu	http://www.governmentofvanuatu.gov.vu/
Venezuela	http://www.ine.gov.ve/
Vietnam	http://www.gso.gov.vn/default_en.aspx?tabid=491
Wallis and Futuna	www.wallis.co.nc/stats
Yemen	http://www.cso-yemen.org/index.php?lng=english&
Zambia	http://www.zamstats.gov.zm/
Zimbabwe	www.zamstats.gov.zm

Appendix 2

Introductory Note for the Requirement Analysis testing session

Welcome

I would like to thank you for taking out time in order to help with this Usability testing session. This testing session is a part of my MSc. Research program. So I really appreciate your coming and thank you so much in advance for your contribution.

Aim

The research topic is: The retrieval and Dissemination of spatio-temporal statistical data through National Statistical websites. The aim of this research is to analyze the users' need concerning the dissemination and retrieval of spatio-temporal statistical data on National statistical offices websites.
Spatio-temporal statistical data are data for different geographic locations such as provinces, municipalities or states and for different moment in time, such as different years.

Purpose

This is to evaluate the current ways in which temporal data are being disseminated on these websites and how users are able to retrieve them for their own personal uses and to determine how better these data can be disseminated from users' perspectives.

About the technique

The techniques use for this research is called the Think aloud, questionnaire and interview techniques. This will involve you as a test participant to fill some questionnaires before and after the testing session along with answering some questions for the questionnaires and interview, while the think aloud technique requires you to carry out some specific tasks and most importantly, say out loud your thought about the tasks you are executing, the procedures, difficulties, comments and what comes to your mind through the process of carrying out these tasks. **This can not be over emphasized.** The whole process of the testing will be recorded both audio and video. I will also like to encourage you to relax and just try to complete the task just as you would normally do in your room or cluster. Once again, thank you for taking time out to participate in this testing session.

Briefly, show the instruments in the usability laboratory.

Instructions for the test session

1. Please fill the first questionnaire while I open the two websites.
2. Please go through the Sheet1 and sheet2 before starting the tasks given.
3. The task involves working with two different websites: the Swedish website and the Nigerian website.
4. Carry out of the task
5. If task cannot be executed, the navigation instruction to the data page of each website is given to carry out the tasks.
6. Estimated time is for Swedish task is 25 minutes and the Nigerian task is 15minutes, please be time conscious.
7. Please, fill the second questionnaire after the test. (15 mins).
8. The estimated time for the test is 60 minutes.

Appendix 3

General Questionnaire for requirement analysis usability testing

1. What country are you from?
2. Are you currently a student of ITC or Graduate of ITC?
3. What course are you studying or did you study in ITC?
4. What is the highest level of degree you currently possess?
5. In what field of specialization?
6. Have you ever worked in a statistical organization before?
7. If Yes, please explain where and in what capacity?
8. Have you ever worked with statistical data?
9. If Yes, for what purpose?
10. Did you use software for work done in question 8?
11. If Yes, what type of software?
12. Have you ever produced map display from data?
13. If Yes, what software was used?
14. Did you ever retrieve, explore, analyze, and visualize statistical data through statistical organisation website?
15. If yes, for what purpose?
16. How would you rate your expertise in using the internet for work purpose?
17. Have you ever worked with Nigerian or Swedish National statistical websites before?
18. If Yes, for what purpose?
19. As a user, what would you like to do with spatio-temporal statistical data if they would be available?
20. How would you like these data to be made available on the National Statistical websites?

Questionnaire for interview session of the requirement analysis usability testing

1. How useful are Tables for analyzing trends and changes that occur in spatio-temporal statistical data?
2. How useful are Charts for analyzing trends and changes that occur in spatio-temporal statistical data?
3. How useful are Single static trend maps for analyzing trends and changes that occur in spatio-temporal statistical data?
4. How useful are Multiple static maps for analyzing trends and changes that occur in spatio-temporal statistical data?
5. How useful are Interactive maps for analyzing trends and changes that occur in spatio-temporal statistical data?
6. How useful are animated maps for visualizing trends and changes that occur in spatio-temporal statistical data?
7. Were the given methods on the Swedish NSO website sufficient for completing the tasks at the given time limit?
8. If No, Why?
9. Were the given methods on the Nigerian NSO website sufficient for completing the tasks at the given time limit?
10. If No, Why?
11. What is your overall impression of dissemination, retrieval and visualization of temporal statistical data on the two websites?

Appendix 4

Researcher's Scenarios

The test Scenario for the Requirement analysis test

1. I will welcome the test participant and show them the equipment used.
2. Explain the aim of the test:
    - I will tell the test participant that the test is part of my research.
    - I will tell the participant the aim of the test is to determine the users' need concerning the retrieval and dissemination of temporal data.
3. I will ex plain that all information is confidential.
4. I will briefly explain what the technique use is about and ask them to say their thoughts out loud and what they are doing.
    - I will tell the test participant that the think aloud is about.
    - I will explain and ask the test participants to say their thoughts out loud while doing the tasks.
5. I will time the test.
6. I will give the test participant the first questionnaire to fill, while I open the Nigeria and Swedish websites.
7. I will give the task to the test participant and give them 5 minutes to read and understand the task and if they have any questions, answer them, then I will leave them to the task.
8. I will ask the test participant to work on the Swedish website first. (15 mins)
9. I will ask the test participant to work on the Nigeria website second. (15 mins)
10. I will then fill the second questionnaire with them after the test. (15 mins)
11. I estimate 45 minutes per test.

Instructions to retrieve data from Swedish websites

Scenarios for Swedish website:

Instructions to retrieve data on Swedish website

Please, navigate to the statistical database by:

- On the menu bar, click **Finding statistics**
- Click **Statistics by subject area,** click **population**, under Population (Population composition), click **population statistics** and under last published, click **tables and graphs.**
- Click: **Make your own tables in the statistical database**
- Click on "Population by region, marital status, age and sex. Year 1968-2008"
- Retrieve the data for **population by county, marital status, age and sex. Year 1968-2008** by clicking on it.

Instructions to retrieve maps on Swedish website

From the home page, type SCB map in the search link

Click on SCB maps

Click on "maps, by subject area"

Click "population change"

SWEDISH WEBSITE

Please, carryout the following tasks

Scenario

1 Suppose you want to have an overview of where most people live in Sweden, by province or county distribution in 2 different years. Is it possible to find the population data for Sweden for year 2002-2008 from the Swedish website?

1b Task rating: Please rate the ease of carrying out the task 1a above:

1 2 3 4 5 6 7 8 9 10

Very Difficult Very Easy

2 How are these data, from task1a above, currently presented on the Swedish website? (Please tick the options below):

Tables
Charts
Multiple static maps
Single static map
Interactive map
Animated map

3 Is it possible to see the trend or change in the distribution of population in Sweden in 2002 compared to 2008 in the methods of retrieval on the website?

3b Task rating: Please rate the ease of carrying out the task 3a above:

1 2 3 4 5 6 7 8 9 10

Very Difficult Very Easy

4 Describe the possibility of visualizing population distribution change of two different years on the single static trend maps given.

4b Task rating: Please rate the ease of carrying out the task 4a above:

1 2 3 4 5 6 7 8 9 10

Very Difficult Very Easy

5 Describe the possibility of visualizing population distribution change of two different years on the multiple static maps given.

5b Task rating: Please rate the ease of carrying out the task 5a above:

1 2 3 4 5 6 7 8 9 10

Very Difficult Very Easy

6 Describe the possibility of visualizing population distribution change of two different years using the interactive maps given.

6b Task rating: Please rate the ease of carrying out the task 6a above:

1 2 3 4 5 6 7 8 9 10

Very Difficult Very Easy

7 From the Canadian animated map shown to you by the researcher, describe the possibility of visualizing population distribution change on the animated maps.

7b Task rating: Please rate the ease of carrying out the task 7a above:

1 2 3 4 5 6 7 8 9 10

Very Difficult Very Easy

Instructions to retrieve data from Nigerian Website

Scenarios for Nigerian website:

Please, navigate to the statistical database by:

- From the home page, under latest release, click **Women & Men in Nigeria**
- Click **open** and extract data on the desktop.
- From the folder W-M in Nigeria, using the PDF documents inside
- Carryout the following tasks on sheet 2.

NIGERIAN WEBSITE

Please, carryout the following tasks.

Scenario

1 Suppose you want to have an overview of where most people live in Nigeria, by state distribution in 2 different years. Is it possible to find the population data for Nigeria for year 1991-2006 from the website?

1b Task rating: Please rate the ease of carrying out the task you just completed:

1 2 3 4 5 6 7 8 9 10

Very Difficult Very Easy

2 How are these data, from task1a above, currently presented on the website of the National Bureau of statistics of Nigeria? (Please tick the options below):

Tables
Charts
Multiple static maps
Single static map
Interactive map
Animated map

3 Is it possible to see the trend or change in the distribution of population in Nigeria in 2006 compared to 1991 in the methods of retrieval on the website?

3b Task rating: Please rate the ease of carrying out the task you just completed.

1 2 3 4 5 6 7 8 9 10

Very Difficult Very Easy

General task

Looking at the multiple static maps, single static map, interactive map, animated map, chart and table available on the websites:

- Describe your impression on the method(s) use for dissemination of statistical data on the Nigerian statistical website?

- Which of these methods would you like to have on a website for dissemination, retrieval and visualization of spatio-temporal statistical data?(please **X** your options)

Method	**Must have**	**Could be nice**	**Not Needed**
Tables			
Charts			
Single static maps			
Multiple static maps			
Interactive maps			
Animated maps			

Must have: Definitely needed
Could be nice: Nice to have but not compulsory
Not Useful: Definitely not needed

Link for Nigerian NSO website
http://www.nigerianstat.gov.ng

Link for Swedish NSO website
(http://www.scb.se/default____2154.aspx)

Links for the maps display
Link for multiple view display:
http://www.h.scb.se/scb/bor/scbboju/bj_htm_en/bj_ssd_en.asp#Population

Link for viewing the animated map display:
http://geodepot.statcan.ca/Diss/Highlights/Page3/AnimatedMap_e.cfm

Appendix 5

General task

Looking at the multiple static maps, single static map, interactive map, animated map, chart and table available on the websites:

- Describe your impression on the method(s) use for dissemination of statistical data on the Nigerian statistical website?

- Which of these methods would you like to have on a website for dissemination, retrieval and visualization of spatio-temporal statistical data?(please **X** your options)

Method	**Must have**	**Could be nice**	**Not Needed**
Tables			
Charts			
Single static maps			
Multiple static maps			
Interactive maps			
Animated maps			

Must have: Definitely needed

Could be nice: Nice to have but not compulsory

Not Useful: Definitely not needed

Appendix 6

Overall summary

Note: The use of colours in the transcribed data indicates similarities and differences in the comments of the test participants and also the results of each task.

S/No	Task	TP1	TP2	TP4	TP5	TP6	TP7	Summary
1a	Suppose you want to have an overview of where most people live in Sweden, by province or county distribution in 2 different years. Is it possible to find the population data for Sweden for year 2002-2008 from the Swedish website?	TP was not able to locate the data although TP was able to locate the database but got confused with the interface of the database. "I thought that was the data when I saw the table".	TP was able to locate the temporal data without the instruction sheet. "This is ok. It is more elaborate and you can just click and obtain the data" but TP did not really understand how to retrieve the data from the database.	TP was able to locate and retrieve data from the database without the instruction sheet. "The data on the website is very organized".	TP was able to locate the database without instruction sheet but was confused about interface of the database. "It seems there is no data on this page. I can only see a table but no data".	TP was not able to locate the data. Using the instruction sheet, "I was actually on this page but because of time, I didn't see it. I could not have found it without the instruction sheet". TP was able to retrieve data from the database.	TP was not able to locate the data. Using the instruction sheet, TP retrieved the data but could not understand the database interface" This website seems a bit clumsy" Researcher had to intervene to help retrieve the data.	Although 3 TPs were able to retrieve the data without help of the researcher while the other 3 could not, 4 of the TPs did not understand the database interface and the researcher had to intervene to explain how the data could be selected and retrieved from the database.
1b	Task rating	5(Not Difficult /Not Easy)	8 (easy)	7(easy)	3(Difficult)	6(Not Difficult /Not Easy)	5(Not Difficult /Not Easy)	
2a	How are these data, from	TP selected only table, "I didn't	Table, charts and maps "but the	TP was able to visualize data in	Table, chart and maps. "I think the	Table, chart and maps.	Tables are used to disseminate the data.	All TP could directly relate with table as a

	task1a above, currently presented on the Swedish website?	recognize the chart icon". Maps.	maps are not easy to find".	Tables but not chart. "I didn't see it".	map retrieval is awkward. The map should be on the database page".		Maps.	form of retrieval while only 3 TPs could directly see and recognize the chart icon.
3a	Is it possible to see the trend or change in the distribution of population in Sweden in 2002 compared to 2008 in the methods of retrieval on the website?	TP could see trend from analyzing the data from the tables, "it is very easy to see the change between two years".	TP could see the trend. "It is possible to see the trend through the available methods on the website especially with chart."	TP was able to see the growth rate by using the tables and analysis.	TP was able to see trend in the formats on the website. "I can see the trend when using the chart".	TP was able to see trend. "I can see a trend using the chart and it is easier than using the tables".	TP could not see any trend. "This task is very difficult".	5 of the 6TPs could see the trend or change in population either by analyzing using tables or visually using charts.
3b	Task rating	10(very easy)	8(Easy)	6(Not Difficult /Not Easy)	3(difficult)	8(easy)	2(very difficult)	
4a	Describe the possibility of visualizing population distribution change of two different years on the single static trend maps given.	TP could not understand the single static map even after studying the legend.	TP was glad to see map and understand the use of the SSM for analysis. Although the researcher doubts that claim because the TP had no proof or correct answer to the task.	TP was able to see the trend using the SSM "but it's not easy".	TP has no understanding of the SSM. "I don't understand this map, how do I distinguish between the changes in the years".	TP has no understanding of the SSM. "I can see population distribution but I can't understand or see the trend or distinguish the years".	TP has no understanding of the SSM. "The spatial aspect of population distribution was ok but the temporal information is not clear or visible".	4 of the TPs could not understand the SSM for the dissemination of spatio-temporal statistical data. They claim not to be able to distinguish between the 2 years specified.
4b	Task rating	4(Difficult)	9(very easy)	5 (Not	2(very difficult)	1(very difficult)	6(Not Difficult/Not	

				Difficult/Not Easy)			Easy)	
5a	Describe the possibility of visualizing population distribution change of two different years on the multiple static maps given.	TP could not open the multiple view windows. TP could not use any trend or see change between two maps, "They look alike and I can see there are no changes".	TP could not open the multiple view windows although he was able to see the trend using the maps. "It was not easy to see".	TP could not open the multiple view windows and TP could not see any change in trend because "the two maps are not showing much difference. This gives me the impression that the visualization of change is not possible".	TP could not open the multiple view windows and TP could not see any change in trend. "This task is not easy. I can't see any changes in these maps. It might be possible but the tools (cartographic variables) are not properly used".	TP could not open the multiple view windows and could not see any change in trend on the two maps. "With my eyes looking at the maps, I can't see any change on the two maps. The colours are and shapes of the objects are the same".	TP could not open the multiple view windows and TP could not see any change in trend. "I can't see much difference between 2002 and 2008 maps. There could have been an Improvement in representation. The understanding is hampered".	All TPs could not open the multiple static windows. Also, 5 of the TPS could not see the trend on the multiple static maps as displayed by the Swedish website. They all commented on the cartographic variables use for mapping these data being exactly similar for the two different years.
5b	Task rating	7(easy)	9(very easy)	6(Not Difficult/Not Easy)	2(very difficult)	3(difficult)	3(difficult)	
6a	Describe the possibility of visualizing population distribution change of two different years using the interactive maps given.	TP was able to use the interactive map and also see the trend and changes "by clicking on the two maps, you can retrieve the figures and compare them."	TP was able to use the interactive map. "This is very good and I don't have to stress myself. I can obtain the data by just clicking on the map".	TP was able to understand the interactive map for analyzing the trend. "By comparing the two outputs, makes it possible to see the difference in the two years given".	TP was able to see changes on the interactive map. "One can perceive changes but the symbols on the map itself are not a true representation of the change that can be seen in the real data".	TP was able to see changes on the interactive map. "Although I will have been nice to have two windows showing the interactivity but this is good".	TP was able to see changes on the interactive map. "Integration of chart with the map will have been much better".	All TP were able to use, understand and love the concept of the interactive map.

6b	Task rating	9(very easy)	10(very easy)	8(easy)	2(very difficult)	9(very easy)	7(easy)	
7a	From the Canadian animated map shown to you by the researcher, describe the possibility of visualizing population distribution change on the animated maps.	TP was able to understand the animated map "I can directly see the trend of population growth".	TP was able to understand directly see and analyze the trend from the animated map. "Oh, this is great; I can directly see the growth and change on this map, but can I stop it?"	TP was able to see the changes on the animated map. "It is possible to see the trend on the animated map but I would expect the map to be interactive".	TP was able to see the changes on the animated map. "This is ok for visualization because one can easily see the spread and perceive the change but it can't be use for analysis".	TP was able to see change on the animated map. "This is lovely. I can see the changes without touching it" Although TP would have preferred to interact with the map. "Is there a way I can pause it? That is a problem because I will like to see the data and even interact with this map"	TP was able to see change on the animated map. "This is nice and beautiful and at a glance user can see the change that occurs on the map with time. Is it possible for one to stop and critically look at the time and data at each particular time?"	All TP were able to use, understand and love the concept of the animated map and they all also tried to relate with it and express the desire to extract data from it. They all also commented on the need to improve the animated map by combining animation with interactivity of the map.
7b	Task rating	9(very easy)	10(very easy)	6(Not Difficult/Not Easy)	6(Not Difficult/Not Easy)	9(very easy)	9(very easy)	

Nigerian website

S/No	Task	TP1	TP2	TP4	TP5	TP6	TP7	Summary
1a	Suppose you want to have an overview of where most people live in Nigeria, by state distribution in 2 different years. Is it possible to find	TP was not able to locate the data on the website, "I was expecting the data to be in the NPC page".	TP was not able to locate data on this website. "I do not expect to be extracting and moreover, this is software dependent as well. I expect the	TP was not able to locate the data. "It is not a simple or straight interface created for data dissemination. This seems not easy to get".	TP was not able to execute this task. "I will prefer an interface where I can select the required data. They world has gone beyond what is being offered by	TP was able to locate the data accidentally from the website. "I don't expect the information or data of 1991 and 2006 to be here".	TP was not able to locate the data. "For end users that hopes to retrieve the data quickly, this is a long journey"	5 of the 6 TPs were not able to locate the statistical data or spatio-temporal statistical data on the Nigerian website. TP expect that the data is stored and disseminated through the NPC link or through a database but not under latest release or as an

	the population data for Nigeria for year 1991-2006 from the website?		data to be in a database".		the website".			attachment in PDF file. TPs expected to be able to retrieve the required data and be able to visualize in different formats such as maps (both interactive and animated maps).
1b	Task rating	4(Difficult)	3(Difficult)	6(Not Difficult/Not easy)	1(Very Difficult)	5(Not Difficult/Not Easy)	3(Difficult)	
2a	How are these data, from task1a above, currently presented on the website of the National Bureau of statistics of Nigeria?	Data are disseminated as tables and charts on a PDF document.	Data are disseminated as tables and charts on PDF file. "I think there should be a map to complement the table".	Data are disseminated using tables and charts. "The information is handy but no map was found on the website".	Data are disseminated in PDF using tables and charts.	Data are disseminated using table in PDF format.	Only Tables. " I can't see any chart "	
3a	Is it possible to see the trend or change in the distribution of population in Nigeria in 2006 compared to 1991 in the methods of retrieval on the website?	TP was able to see trend using the tables of two different years available on the PDF. "By comparing the data on the table for the two years"	TP was able to see trend using the tables of two different years "but visualization of the trend is not easy".	TP commented that it is possible to see trend. "Although, getting information from the website was not east to get, there is need for improvement".	TP was not able to see trend. "It is not possible to see trend on the website".	TP was not able to see trend from the methods available on the website. "It can only be computed from the table".	TP was not able to see the trend. "Although it is possible by analyzing the table but not in the visual way".	TPs commented on the possibilities of computing to derive the changes but 3 TPs insisted on not able to see the trend through the table format used on the PDF while the other 3 TPs claim to see the trend although with difficulties.
3b	Task rating	10(very easy)	4(Difficult)	6(Not Difficult/Not easy)	10(very easy)	10(very easy)	3(Difficult)	

Post Questionnaire (This defines the effectiveness of the methods)

Methods	TP1	TP2	TP4	TP5	TP6	TP 7	Summary
Tables	Tables are important. "You can compare the figures and see the trend".	Tables are important. "Table is like water and blood to humans. You can't do without them although you need to complement them with maps"	Tables are important. "They show trend in analyzing spatio-temporal statistical data".	Tables are useful for analyzing. "Because without tables, we can't produce the other methods of visualization".	Tables are not useful. "I don't like table, it is not visually attractive. They are not good for visualization of too many data".	Tables are not useful. "it is long and winding process"	Although all TPs claim that tables are important for dissemination and retrieval of spatio-temporal statistical, 2 TPs commented that it is not useful and easy for visualization by users, especially for a large dataset.
Charts	Charts are ok "but not everyone can use it".	Charts are good. "They allow you to see trend".	Charts are important and useful but "they become clumsy with increase in the number of years".	Charts are good but not needed in all cases. "But in looking for distinction and spatio-temporal data, not really necessary".	Charts are good. "I will subscribe for chart because you can directly see the trend although the disadvantage is that you don't get the actual figures".	Charts are useful. "They provide visual representation of changes that had occurred over the years".	All TPs commented on the usefulness of charts for the visualization of trends. 1 TP commented that it is not needed in all cases and another TP commented that it's not everybody that can understand the use of chart for visualization of spatio-temporal statistical data.
Single Statics maps	SSM are not useful.	SSM are ok but not so useful.	SSM are good. "It shows trend".	SSM are useful, "but not the one on the Swedish website".	SSM is not good. "I could not see any trend or change and the legend is not helpful".	SSM are not useful. "It is confusing".	4 TP commented that SSM are not so useful for dissemination of temporal data, especially the ones presented on the Swedish website, which they claim are confusing.
Multiple Static maps	MSM are useful. "You can compare the two maps".	MSM are very good.	MSM could be useful "but the one on the Swedish website is not so visible".	MSM are ok. "It's ok but not so necessary in visualization".	MSM is not so useful. "I could not see any trend or change and the legend is not helpful".	MSM are not useful. "They are more confusing than SSM because there are no color differences. They look the same to	4 TPs commented on the usefulness of MSM for visualization of spatio-temporal data although like the SSM, they claim the MSM on the Swedish websites are more confusing than useful for visualization of trends

						me".	of the temporal data.
Interactive maps	Interactive map are useful. "allows for retrieving information hidden in the map"	Interactive map is very good. "They give you basic and necessary information needed".	Interactive map are useful. "This is useful because it show the trend by giving information and data of points clicked on".	Interactive map are useful. "They tell what and where such information is available on the website".	Interactive map are useful. "This is good because I can retrieve the figures".	They are useful. "They give the actual data".	All TPs commented on the usefulness of the interactive maps for retrieval and visualization of temporal data. Unlike in table, they claim it is possible to compare the data retrieved through the interactive maps easily.
Animated map	Animated map is very useful. "Because it allows for direct visualization of change on the map".	Animated map is very good "but it will give the best result if it is interactive".	Animated map is very useful. "This is very good but I would prefer it to be interactive".	Animated map is very useful. "It is seen as very necessary in modern mapping and it will be better if it can be enhanced".	Animated map is very useful. "This is very good. I think visually, this is good for a large range of years".	Animated map is very useful. "They are more useful. Although I would prefer it is interactive and I can click, stop and give me the real value of the data".	All TPs commented on the usefulness of the animated maps for visualization of temporal statistical data. They claim it is simple and very easy to understand by just looking at the map and the legend helps to understand the trend better.
Overall impression	Swedish website is better in dissemination, retrieval and visualization of data than the Nigerian website because "there are no varieties of methods selection on the Nigerian website".	Methods on the Swedish website are sufficient for solving the tasks given while the Nigerian website is not because "there is no map and the method of retrieval is cumbersome. It is also software dependent".	Swedish website is better in dissemination, retrieval and visualization than the Nigerian website. "I would never have been able to retrieve the data without the instruction sheet"	Swedish website methods are sufficient for solving the tasks while Nigerian website is not "because the environment is weird and it should be linked not extracted document. Nigerian website needs to be improved on greatly".	Swedish website methods are good but the Nigerian website is not. "There is no map, not even a static map".	Swedish website methods are not good "because the database requires another study" but the Nigerian websites are worst. "I expect NPC to disseminate the data not as an attachment".	The overall impression of the TPs is that the Swedish website has a more user-friendly interface and it is much better and advanced in the dissemination, retrieval and visualization of temporal statistical data on the website and that there is a great need to improve on the Nigerian website for both the interface and also for better dissemination, retrieval and most importantly visualization of these data.

General Task (Usefulness)

General Task	TP1	TP2	TP3	TP4	TP5	TP6	TP7	Summary
Tables	MH	MH	MH	CBN	MH	MH	CBN	For the table, 66.7% (4 TPs) insisted that tables are must have for dissemination and retrieval of spatio-temporal statistical data but 33.3% (2 TPs) insisted it could be nice to have tables but not a must have. All TPs agree that it is very necessary for analysis and data storage, in order to produce the other forms of visualization methods, but it should not be the only means of visualization as could be found on the Nigerian website because it is tedious and cumbersome to analysis especially when there are large volume of data and years to visualize.
Charts	CBN	MH	MH	CBN	CBN	MH	MH	50% (3 TPs) agreed that it is a must have while 50% (3 TPs) said it could be nice to have charts on the websites for dissemination and retrieval of spatio-temporal statistical data, although they all favored the use of chart for visualization. The TPs all agreed that it give a quick overview of the changes that had occurred over the years and it is a good means of visualization for overview of spatio-temporal statistical data on NSO websites.
Single static maps	-	MH	CBN	MH	MH	CBN	CBN	Although 50% (3 TPs) selected the use of single static map as must have and 33.3% (2 TPs) selected could be nice and 16.7% (1 TP) refused to make any selection on the use of single static maps for visualization, all TP commented that they could not really understand the single static map as presented on the Swedish website due to the confusing legend on the map. It was also clear for the testing that the users do not understand the use of single static maps generally.
Multiple static maps	MH	MH	CBN	MH	NN	CBN	CBN	50% (3 TPs) of the TP considered the use of Multiple static map as a must have on the website, 33.3% (2 TPs) also considered it as could be nice while 16.7% (1 TP) TP said it is not needed, but all TP agreed that the multiple static map on the Swedish website is more confusing than being helpful. They all commented that the use of better cartographic variables for visualization of spatio-temporal data using this method is necessary.
Interactive maps	MH	MH	CBN	MH	MH	MH	MH	All TPs commented on the fact that the use of interactive maps for dissemination of spatio-temporal statistical data on NSO websites can not overemphasize. They all commented on the effectiveness of this method for dissemination of the actual

								value of the data while it was still possible to visualize the changes on the maps and the data retrieved through the interactive maps can also be use for simple analysis to determine the trend of change over the selected years.
Animated maps	MH	MH	NN	MH	MH	CBN	MH	83.3% (5 TPs) of the TP agreed that the use of animated map is the current and the best way for visualization of any changing data such as the spatio-temporal statistical data. They all commented on the ease of understanding the distribution pattern and the trend or changes that occurs within the data over the years by just looking at the map and they all agreed that it is a must have method on the website.. Although, they all commented on the fact that it will be more useful if the animated map could also be interactive and there is opportunity to stop and retrieve the actual data behind the animation at anytime needed by the user.

Overall summary

Methods	MH	CBN	NN
Tables	4	2	0
Chart	3	3	0
SSM	3	2	1
MSM	3	2	1
Interactive map	6	0	0
Animated map	5	1	0

Note
General Task: Must Have (MH), Could Be Nice (CBN), Not Needed (NN)

Summarize Performance Data
Task Accuracy
Summarize Performance Data
Task Accuracy: Percentage of participants performing successfully including those that needed assistance:
Percentage of participants performing successfully (PS)
Percentage of participants performing successfully with assistance of Researcher (PSR)
Percentage of participants performing successfully within the time given (PST)

Swedish Website

S/No	Task	TP1	TP2	TP4	TP5	TP6	TP7	Summary
1a	Suppose you want to have an overview of where most people live in Sweden, by province or county distribution in 2 different years. Is it possible to find the population data for Sweden for year 2002-2008 from the Swedish website?	Incomplete (TP could not use the database interface even after assistance of the researcher).	Complete (PSR)	Complete (PS)	Complete (PSR)	Complete	Incomplete	For this task, 3 were not able to locate the data without help, 4 needed help to understand the database, 2 were able to retrieve the data without help and only one TP completed the task without help.
2a	How are these data, from task1a above, currently presented on the Swedish website?	Incomplete (TP did not see the chart icon).	Complete	Complete	Complete	Complete	Incomplete	4 TPs were able to answer the task correctly, while the other two were not able to locate the chart icon
3a	Is it possible to see the trend or change in the distribution of population in Sweden in 2002 compared to 2008 in the methods of retrieval on the website?	Complete	Complete	Complete	Complete	Complete	Incomplete	4 TPs were able to see the trend using the charts, while 1 TP was able to see the trend by studying and analysis the tables and the last TP could not see the trend.
4a	Describe the possibility of visualizing population distribution change of two different years on the single static trend maps given.	Complete	Incomplete (Because TP could not really explain what the map was about).	Complete	Complete	Complete	Complete	4 TPs could not see the trend using the SSM while two could see the trend, although they commented," but it's not easy".
5a	Describe the possibility of visualizing population distribution change of two different years on the multiple	Complete (PSR)	Complete (PSR)	Complete (PSR)	Complete (PSR)	Complete	Complete	5 TP could not see the trend using the MSM on the Swedish website. They commented that it was due to poor cartographic variables used.

	static maps given.							"They are more confusing than SSM because there are no color differences. They look the same to me".
6a	Describe the possibility of visualizing population distribution change of two different years using the interactive maps given.	Complete	Complete	Complete	Complete	Complete	Complete	ALL TP were able to complete the task.
7a	From the Canadian animated map shown to you by the researcher, describe the possibility of visualizing population distribution change on the animated maps.	Complete	Complete	Complete	Complete	Complete	Complete	ALL TP were able to complete the task.

Nigerian website

S/No	Task	TP1	TP2	TP4	TP5	TP6	TP7	Summary
1a	Suppose you want to have an overview of where most people live in Nigeria, by state distribution in 2 different years. Is it possible to find the population data for Nigeria for year 1991-2006 from the website?	Complete	Complete	Complete	Complete	Complete	Complete	Only one TP was able to complete the task without help.
2a	How are these data, from task1a above, currently presented on the website of the National Bureau of statistics of Nigeria?	Complete	Complete	Complete	Complete	Complete	Complete	

3a	Is it possible to see the trend or change in the distribution of population in Nigeria in 2006 compared to 1991 in the methods of retrieval on the website?	Complete	Complete	Complete	Incomplete	Incomplete	Incomplete	3 TP commented on the possibility to see trend by studying the tables and analyzing the data while 3 TP commented on not being able to see the task.

Task Timings

Task Timings: This is timing how much time each TP requires to complete each task. The mean time, when compared to the set time for the task gives an indication of the performance of the task.

Note: Although there was no set time for each individual task, there was an estimated time for each website and the total sum of the TPs time will be compared with this estimated time, although the individual time will also be recorded to determine the task with the longest time of execution and TPs comment on the task.

Swedish Website

S/No	Task	TP1	TP2	TP4	TP5	TP6	TP7	Summary
1a	Suppose you want to have an overview of where most people live in Sweden, by province or county distribution in 2 different years. Is it possible to find the population data for Sweden for year 2002-2008 from the Swedish website?	11:32	6:46	15:43	7:24	10:55	8:59	(5 min)+(5 min)
2a	How are these data, from task1a above, currently presented on the Swedish website?	0:45	1:55	1:50	0:47	0:50	1:14	
3a	Is it possible to see the trend or change in the distribution of population in Sweden in 2002 compared to 2008 in the methods of retrieval on the website?	1:00	0:47	1:55	1:48	1:37	0:45	(4 min)
4a	Describe the possibility of visualizing	2:10	0:52	2:14	3:50	4:46	2:53	(4 min)

	population distribution change of two different years on the single static trend maps given.							
5a	Describe the possibility of visualizing population distribution change of two different years on the multiple static maps given.	2:50	3:20	4:29	17:19 (5:04)	3:47	2:10	(4 min)
6a	Describe the possibility of visualizing population distribution change of two different years using the interactive maps given.	2:20	2:05	2:07	3:27	1:30	3:10	(4 min)
7a	From the Canadian animated map shown to you by the researcher, describe the possibility of visualizing population distribution change on the animated maps.	2:13	1:04	1:18	1:21	1:59	2:46	(4 min)
	Total	22:50	16:49	29:36	23:41	25:24		

Nigerian Website

S/No	Task	TP1	TP2	TP4	TP5	TP6	TP7	Summary
1a	Suppose you want to have an overview of where most people live in Nigeria, by state distribution in 2 different years. Is it possible to find the population data for Nigeria for year 1991-2006 from the website?	7:40	8:40	8:30	6:43	5:35	10:34	(5 min) +(5 min)
2a	How are these data, from task1a above, currently presented on the website of the National Bureau of statistics of Nigeria?	0:40	1:49	4:22	1:19	1:20	2:18	

3a	Is it possible to see the trend or change in the distribution of population in Nigeria in 2006 compared to 1991 in the methods of retrieval on the website?	3:13	4:05	3:10	3:25	1:05	1:39	(5min)
	Total Time Taken	11:33	14:34	16:02	11:27	8:00	14:31	

Mean = $\text{Sum of all participants completion times} \,/\, \text{Number of participants}$

Standard deviation (SD) = ($\sqrt{\sum x2 - (\sum x)2}$ /n) / n-1

For the Swedish website

Task	Tp1	Tp2	Tp4	Tp5	Tp6	Tp7	summary
Interface	Difficult	Not Difficult	Not Difficult	Not Difficult	Difficult	Difficult	There is need to improve the interface of the NSO websites for easy navigation of users and also the use of search function is required.
Database	Difficult	Difficult	Not Difficult	Difficult	Not Difficult	Difficult	The retrieval process should be made as simple as possible. This is necessary for
Tables	Effective	Effective	Effective	Effective	Not Effective	Not Effective	Majority of the test participants find the use of tables for retrieval of data important.
Charts	Effective	Effective	Effective	Effective	Effective	Effective	All test participants find the use of chart effective for retrieval and visualization of temporal data.
SSM	Not Effective	Not Effective	Effective	Effective	Not Effective	Not Effective	Majority of the test participants find the SSM not effective.
MSM	Not Effective	Not Effective	Not Effective	Not Effective	Not Effective	Not Effective	All test participants find the MSM not effective.
Interactive	Effective	Effective	Effective	Effective	Effective	Effective	All test participants find the interactive map effective.

Animated	Effective	Effective	Effective	Effective	Effective	Effective	All test participants find the animated map effective.

Figure 1: Below shows the overall result of the analysis of the Swedish website.

Nigerian website

Interface	Difficult	Difficult	Difficult	Difficult	Not Difficult	Difficult	Majority of the test participants find the database difficult. There is need to improve the interface of the NSO websites for easy navigation of users and also the use of search function is required.
Database	Difficult	Difficult	Difficult	Difficult	Difficult	Difficult	All test participants find the database difficult to use. The retrieval process should be made as simple as possible.
Tables	Effective	Effective	Effective	Not Effective	Not Effective	Not Effective	3 out of the 6 test participants find the use of tables for retrieval of data important. Therefore tables should be included.

Figure 2: Below shows the overall result of the analysis of the Nigerian website.

Note: Using the rating and comments of test participants and screen logging, the satisfactory and effectiveness table was created.

Interface

Methods	very difficult	difficult	no difficult/no easy	easy	very easy
swedish website	1	1	1	3	0
Nigerian website	1	3	2	0	0

Database

Methods	very difficult	difficult	no difficult/no easy	easy	very easy
swedish website	0	3	1	2	0
Nigerian website	0	0	0	4	2

Tables

Methods	very difficult	difficult	no difficult/no easy	easy	very easy
Swedish website	1	2	3	1	0
Nigerian website	0	4	1	0	1

Overall Usefulness

Methods	Must Have	Can Be Nice	Not Needed
Tables		4	2
Chart	3	3	0
SSM	3	2	1
MSM	3	2	1
Interactive map	6	0	0
Animated map	5	1	0

Methods	Must Have	Can Be Nice	Not Needed
Tables	4	2	0

Methods	Must Have	Can Be Nice	Not Needed
Chart	3	3	0

Methods	Must Have	Can Be Nice	Not Needed
SSM	3	2	1

Methods	Must Have	Can Be Nice	Not Needed
MSM	3	2	1

Methods	Must Have	Can Be Nice	Not Needed
Interactive map	6	0	0

Methods	Must Have	Can Be Nice	Not Needed
Animated map	5	1	0

Appendix 7

Result of my analysis

Interface

The chart below shows the combination of the output of the result of the users for the interface of the Swedish and Nigerian websites. Looking at the chart, it is obvious that majority of the test participants found the dissemination of statistical data on the Nigerian website more difficult than on the Swedish websites.

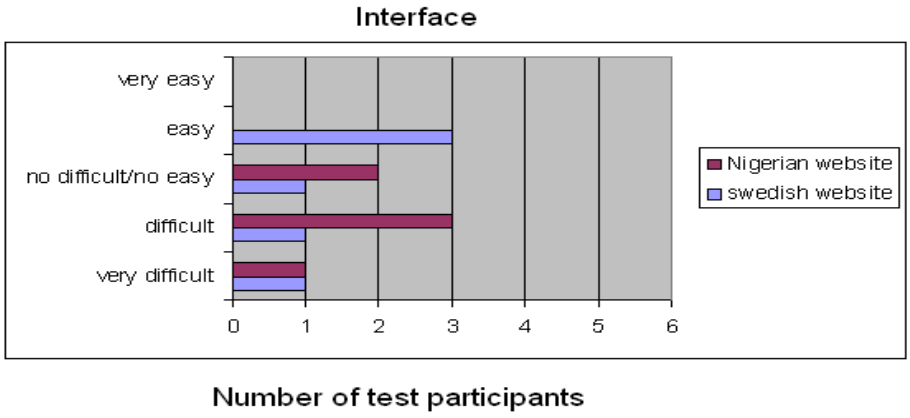


Figure 1:

For the database, there is a clear distinction in the process of retrieval of data from both websites. The Swedish websites provides an interface for retrieval of data from the website, while the data are disseminated using a PDF documents. However, it is interesting to know that although all the test participants were not satisfied with this format of retrieval of data on the Nigerian website, they still rated it more satisfactory than the Swedish website. This is due to the fact that users are more familiar with data on the PDF format than the Swedish method of data retrieval.

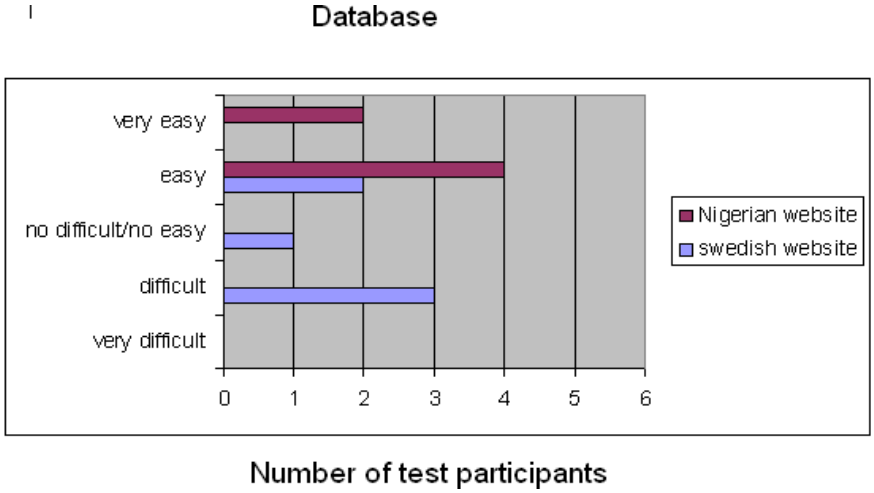


Figure 2:

TABLES

Tables are the most common method of dissemination, retrieval and visualization used by all NSO websites for dissemination of data. From the output of the results obtained from the testing session, majority of the test participants found the tables on the Nigerian website less effective than that of the Swedish website. This was due to the retrieval methods used by both websites. For the Swedish website, it was possible for test participants to retrieve just the required tables, while on the Nigerian website, test participants could not interact with the data.

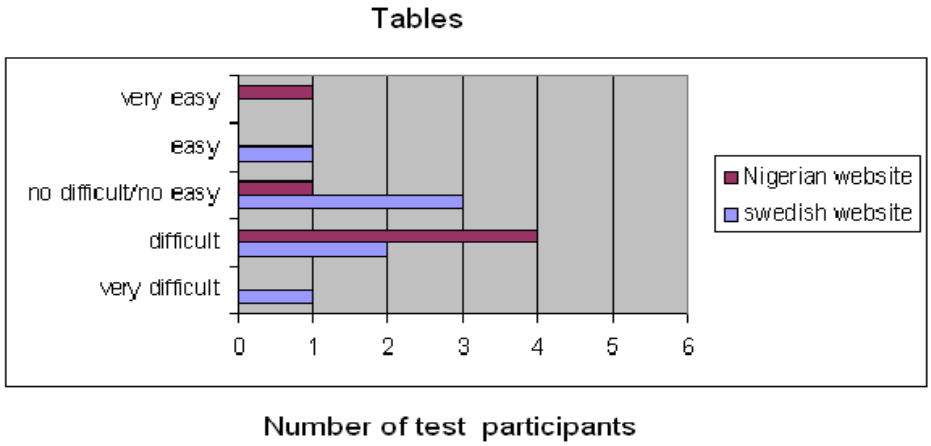


Figure 3:

Looking at the figure3, it is easy to see that most users consider the table an important and must have method for dissemination and retrieval of temporal statistical data.

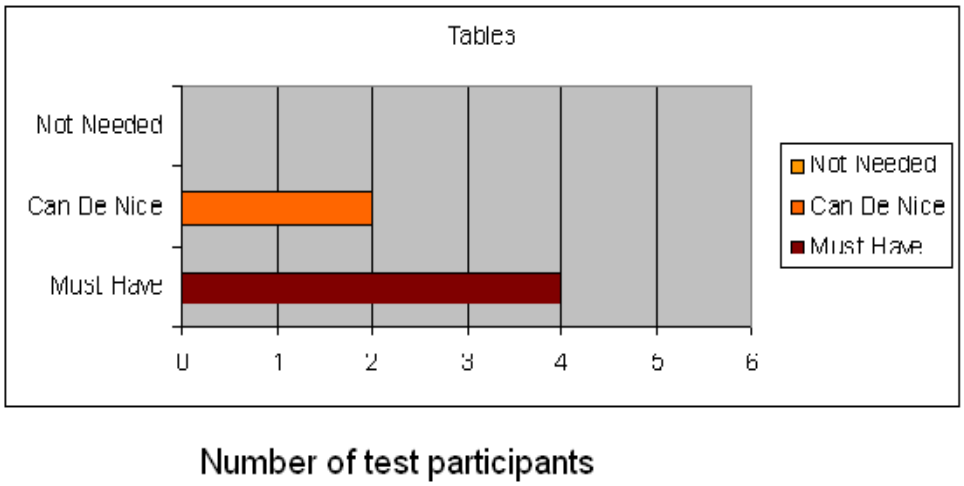


Figure 4:

Overall, although tables are difficult to use for visualization of temporal data, test participant find it an important and necessary method on the NSO websites.

CHARTS

From the observation made from the usability testing, the chart was only noticed by 3 of the test participants and they all rated the use of chart for dissemination and retrieval of temporal data effective.

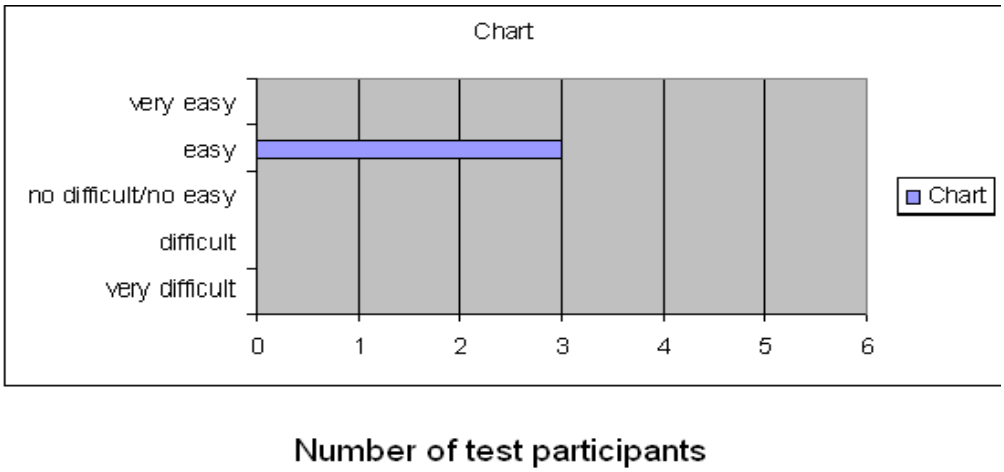


Figure 5:

Looking at 5, only half of the test participants commented that the chart is very important for dissemination of temporal statistical data.

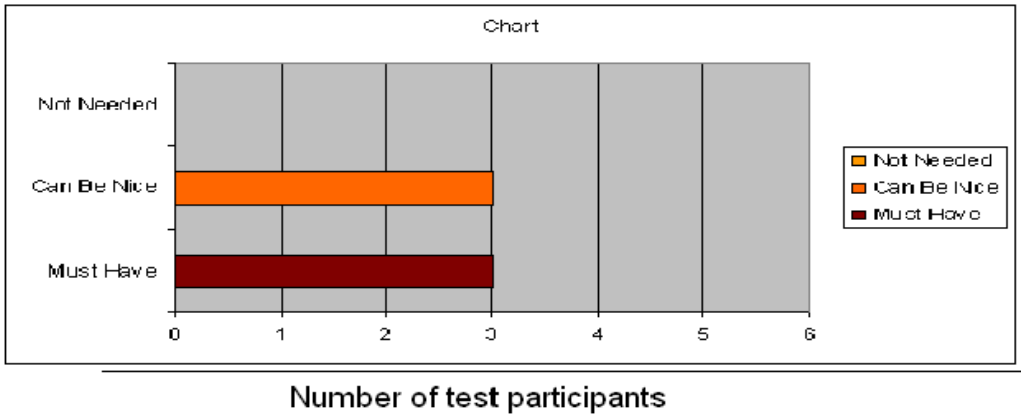


Figure 6:

SINGLE STATIC MAP (SSM)

The single static map rated as difficult or very difficult by half of the test participants as can be seen in figure 7 below. This was due to the fact that majority of the test participants could actually not understand the SSM as it was disseminated and retrieved on the Swedish website.

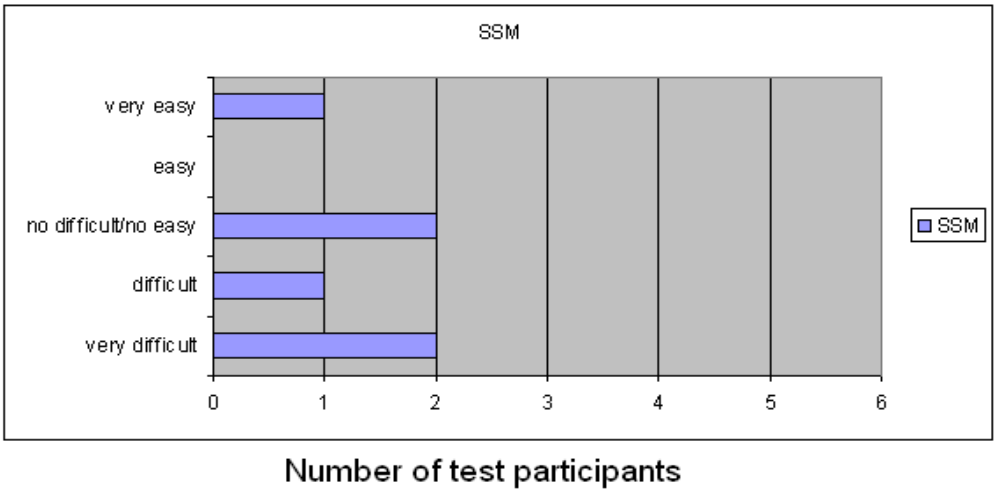


Figure 7:

Although, looking at figure 8 below, majority commented that it was necessary or could be nice to have the single static map on a NSO website for retrieval and visualization of temporal statistical data, but with better legend.

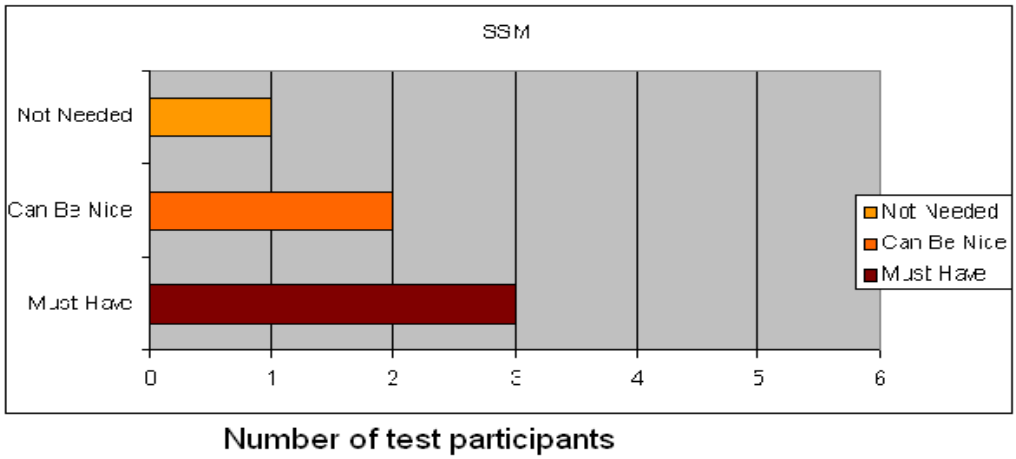


Figure 8:

MULTIPLE STATIC MAPS (MSM)

Like the SSM, the MSM was rated difficult by half of the test participants and this was due to the confusing method of dissemination and retrieval of the MSM on the Swedish website.

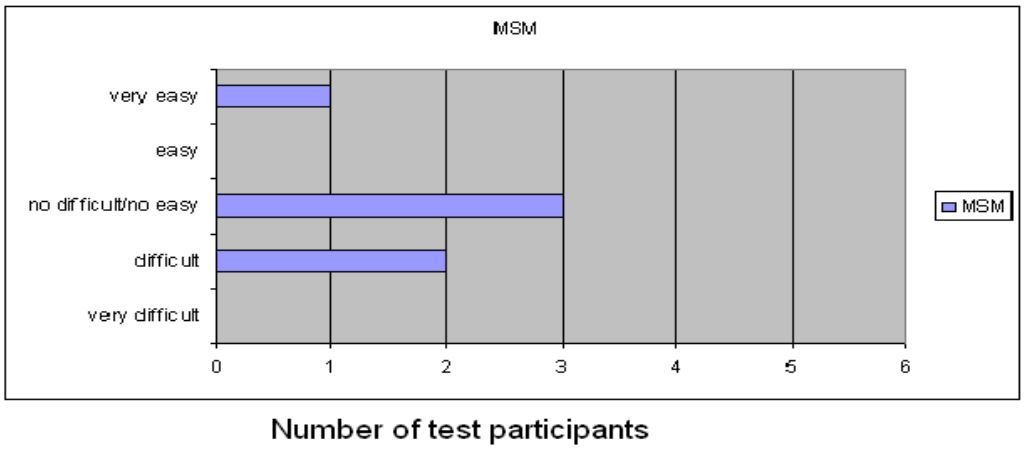


Figure 9:

Also, like the SSM, the MSM was rated by majority as a “must have” or “could be nice”.

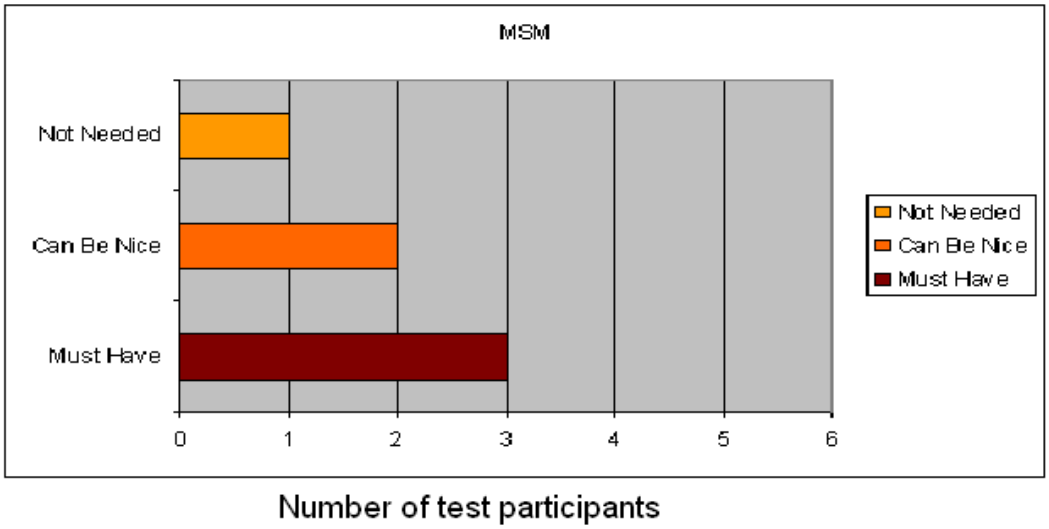


Figure 10:

For examples of the SSM and MSM maps as could be obtained on the Swedish website, see figure 9 and 10.

INTERACTIVE MAP

The interactive map was rated as very easy and easy by all test participants and many made comments about its effectiveness for dissemination, retrieval and visualization of temporal statistical data. It was most effective and satisfactory for test participants when combined with SSM.

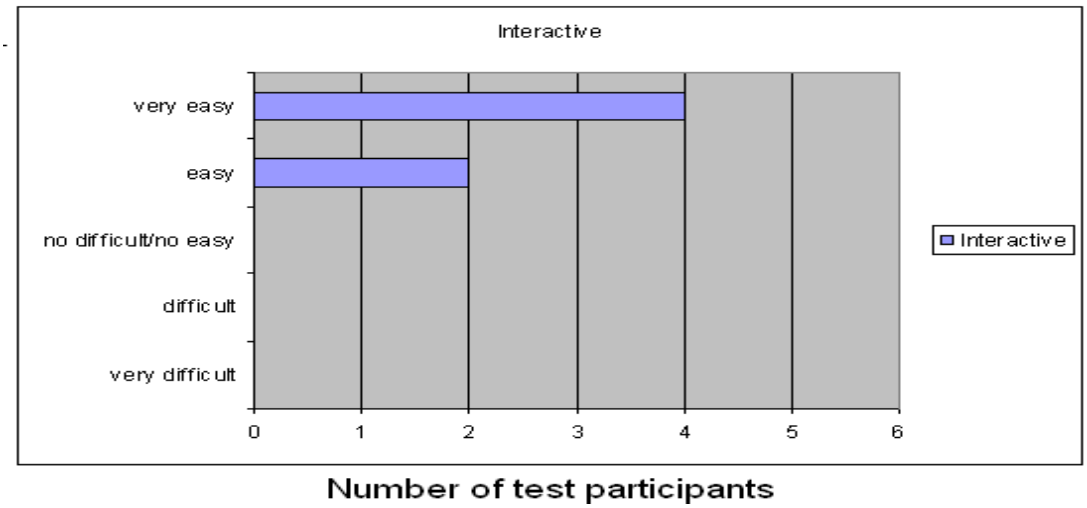


Figure 11:

As can be deduced from figure 12, all test participants rated interactive maps as a must have on NSO websites.

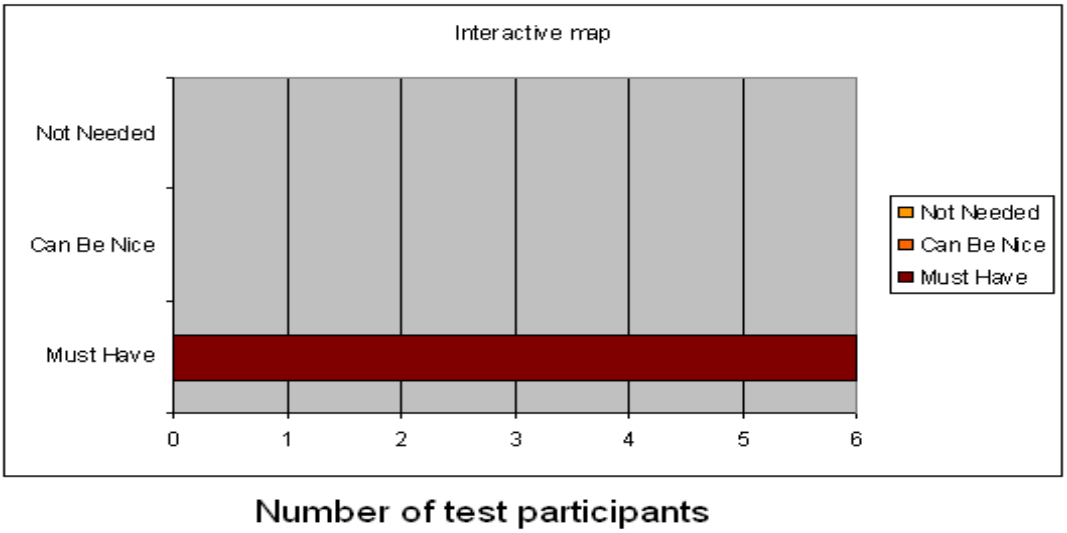


Figure 12:

ANIMATED MAP

The animated map was another very popular method of visualization that was highly satisfactory from the users' perspective. Majority of the test participants rated the animated map are easy or very easy to use and understand from their perspectives.

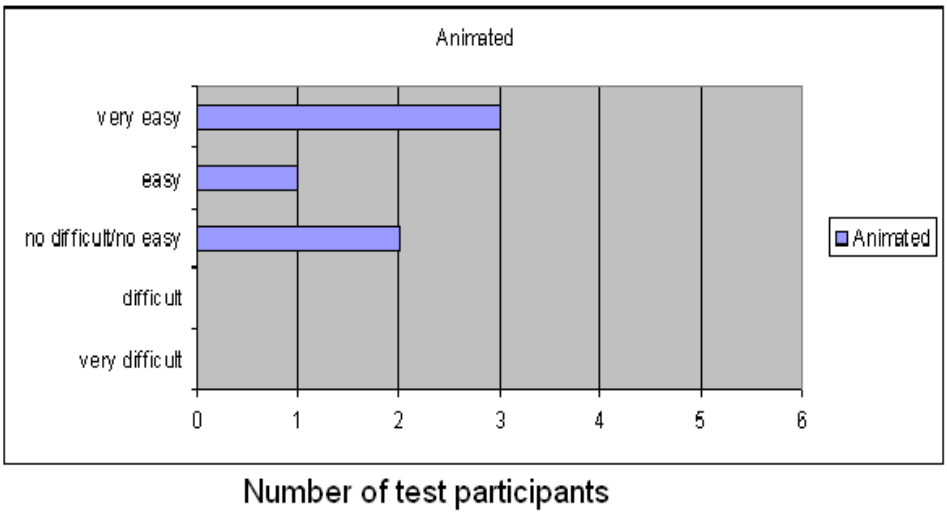


Figure 13:

Looking at figure 14, it is obvious that almost all the test participants rated the animated map as a "must have" method any NSO website.

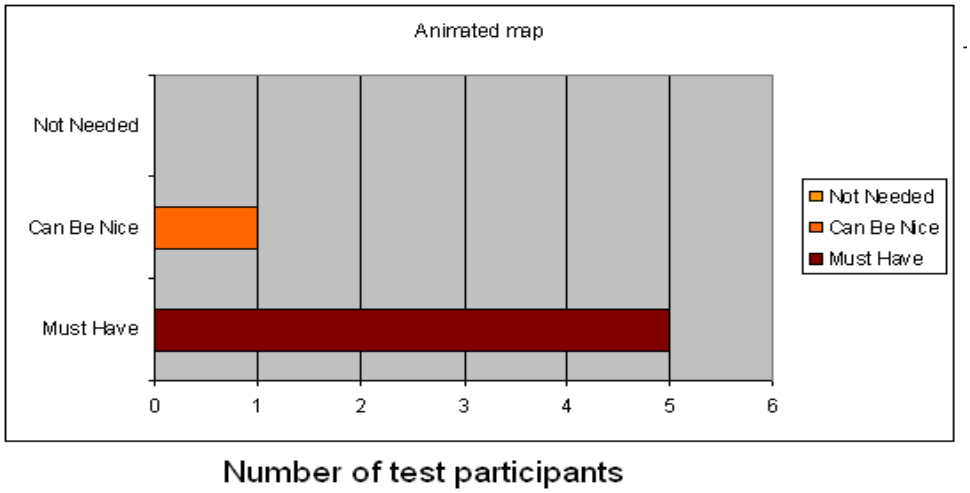


Figure 14:

Although it was also observed that all test participants also commented that it would be nice if the animated map was interactive as well, making it possible for users to stop, pause or replay the animation.

In conclusion, it is obvious that all test participants find the use of animated and interactive maps easy, effective and satisfactory from users' perspective.

Appendix 8

QUESTIONNAIRE FOR PROTOTYPE EVALUATION

1. What country are you from?
   - Please Specify:
2. What course are you studying or did you study in ITC?
   - Please Specify:
3. What is the highest level of degree you currently possess?

   (A)PHD (B) MSC (C) BSC (D) Others (specify) _____
4. What is your field of specialization?
   - Please Specify:
5. Have you ever worked in a statistical organization before?

   Yes No
6. Please explain where and in what capacity?
   - Please Specify:
7. Have you ever worked with statistical data?

   Yes No
8. For what purpose?
   - Please Specify:
9. Have you ever produced map display from data?

   Yes No
10. What software was used?
    - Please Specify:
11. Did you ever retrieve, analyze or visualize statistical data through statistical organization website?

    Yes No
12. For what purpose?
    - Please Specify:
13. How would you rate your expertise in using the internet for work purpose?

    (A) Poor (B) Average (C) Good (D) Excellent
14. What is your level of expertise in the use of maps for retrieval and visualization of data on the internet?

    (B) Poor (B) Average (C) Good (D) Excellent

14. Have you ever worked with Nigerian or any other National statistical websites before?

Yes No

15. For what purpose?

- Please Specify:

Appendix 9

- Tasks for Prototype evaluation session
- INSTRUCTIONS: Please write the answers in the sheet where indicated and say your thought out load at all times.

- Suppose you want to know where most people live in the Northern part of Nigeria, by state distribution in 2 different years. Is it possible to find the state(s) with the largest number of inhabitants in the Northern part of Nigeria for the years 1999 and 2005?
- Please Tick: Yes No
- Please write the name of the state(s):
- What method(s) did you apply to answer this question above? Please state:

1b Task rating: Please rate the ease of carrying out the task 1a above:

1	2	3	4	5
Very Easy	Easy	Not Difficult/Easy	Difficult	Very Difficult

2a Let us consider population density now (number of inhabitants per km2). Are there differences in the changes of population density in the period 1999-2005 between different parts of the country?

- Please write the name and population:

- What tool(s) did you apply to answer this question above? Please state:

2b Task rating: Please rate the ease of carrying out the task 2a above:

1	2	3	4	5
Very Easy	Easy	Not Difficult/Easy	Difficult	Very Difficult

3a. Please consider population density (number of inhabitants per km2). Are there differences in the changes in the population density in different parts of the country in the period 1999 and 2006?

- Please comment.

- What tool(s) did you apply to answer this question above? Please state:

3b Task rating: Please rate the ease of carrying out the task 3a above:

1	2	3	4	5
Very Easy	Easy	Not Difficult/Easy	Difficult	Very Difficult

4a. For 1999-2001 and 2005-2006, is it possible to determine percentage change in population density for states in the country?

- Please Tick: Yes No
- Please, mention few states and estimate their percentage changes in population density.

4b Task rating: Please rate the ease of carrying out the task 4a above:

1	2	3	4	5
Very Easy	Easy	Not Difficult/Easy	Difficult	Very Difficult

5a. Using the absolute number of population map per year, do you see differences in the rate of change between different parts of the country? If so, please describe these regional differences.

- Please Tick: Yes No

5b Task rating: Please rate the ease of carrying out the task 5a above

1	2	3	4	5
Very Easy	Easy	Not Difficult/Easy	Difficult	Very Difficult

Appendix 10

Interview session for the prototype evaluation session

- As a user, are you satisfied with the methods of dissemination, retrieval and visualization of spatio-temporal data in the prototype?

- Were the methods in the prototype sufficient for the execution of your given tasks?

- Why were the selected methods for tasks 1, 2 and 3 selected and not the other tools?

- Overall, do you think the prototype was sufficient for answering all the given tasks correctly and in good time frame?

- Clarify any issue made by test participants that might lead to interesting information or more insight on the test participant's remarks.

- How does the animation help in for visualization purpose?

Appendix 11

Introductory Note for the Prototype usability testing session

Welcome

I would like to thank you for taking out time in order to help with this prototype testing session. This testing session is the final part of my MSc research program and it involves the evaluation of my prototype and all information is confidential. I really appreciate your coming and thank you so much in advance for your contribution.

Aim

My research topic is: The dissemination, retrieval and visualization of spatio-temporal statistical data through National Statistical websites. The aim of this research is to analyze the users' need concerning the dissemination, retrieval and visualization of spatio-temporal statistical data on National statistical offices websites and develop an improve prototype based on users requirement.

Spatio-temporal statistical data are data for different geographic locations such as provinces, municipalities or states and for different moment in time, such as different years.

Purpose

The purpose of this testing session is to evaluate the effectiveness and efficiency of the developed prototype and also users' satisfaction. The session will also be evaluating the various ways and methods in which users retrieve and visualize spatio-temporal statistical data.

About the technique

The techniques use for this research is called the think aloud, questionnaire and interview techniques. This will involve you as a test participant to fill some questionnaires before and during the testing session for the questionnaires, while the think aloud technique requires you to carry out some specific tasks and most importantly, say out loud your thought about the tasks you are executing, the procedures, difficulties, methods chosen and why, throughout the process of carrying out these tasks. A brief interview will be conducted also at the end of the testing session. The whole process of the testing will be recorded both audio and video. In addition, the each task will be timed, so please be time conscious.

I will also like to encourage you to relax and just try to complete the task just as you would normally do in your room or cluster. Once again, thank you for taking time out to participate in this testing session.

Briefly, show the instruments in the usability laboratory.

Instructions for the test session

9. Please think out loud as you fill the first questionnaire.
10. The task involves working with the prototype of the spatio-temporal part of the Nigerian NSO website.
11. From the homepage, click spatio-temporal statistical data.

12. Carry out of the task and each task is estimated to take about 4 minutes.
13. Please be time conscious.
14. A brief interview of about 10 minutes will be conducted at the end of the session

7. Estimated time is for the test session is 40 minutes.

Any question?

Appendix 12

Prototype Usability Testing Draft

Aim of conducting the test

The aim of this test is to determine the effectiveness and efficiency of the prototype for retrieval and visualization of spatio-temporal statistical data as well as the satisfaction of its users.

- To determine how suitable the prototype that was developed based on the results obtained from the users' requirement analysis satisfies the users' need for the retrieval and visualization of spatio-temporal data from the Nigerian NSO website prototype and whether the prototype is effective, efficient and satisfactory to the users of an NSO website.

- To determine how users actually retrieve data from the NSO website, what methods are used and why.

What I expect to find out

- If the prototype is effective, efficiency and satisfactory to users.
- How users retrieve data from the website.
- What methods are used for answering the users' questions.

Case Study

The case study for the usability evaluation is the prototype of the spatio-temporal part of the Nigerian NSO website. The prototype is a proposal for the improvement of one part of the Nigerian NSO website and focuses on the dissemination, retrieval and visualization of spatio-temporal statistical data.

What techniques and why?

Think aloud method: This technique is a qualitative technique that involves the use of five to nine test participants. This test will be recorded both audio and video, and also screen logging. This technique was selected because it will allow the researcher to have the opportunity to watch the test participants perform the given tasks and also what is shown on their computer screen. It also allows for replay of the scenarios of the test as carried out by the test participants. This gives more opportunity of extracting information on how users executed the given tasks with the prototype, which might not have been possible with other techniques such as focus group. The technique allows for comparing the users activities with what users actually say during the execution of the tasks. Based on this, the effectiveness, efficiency of the prototype can be determined.

Questionnaire: The questionnaire is a technique which involves test participants filling out some predefined questions before (see appendix 8) and during the testing session (sees appendix 9). This technique was selected because it can easily be combined with the think aloud technique to collect useful information about test participants and tasks executed. The questionnaire (also called survey), can be used as a quantitative or qualitative technique. For this testing session, the first questionnaire will be used to collect simple background information about test participants and their knowledge and

level of interaction with the internet as a means of retrieving and visualizing information and most importantly, statistical information. The second questionnaire will be used during the execution of the tasks. Test participants will be expected to fill in some answers related to their tasks directly into the questionnaires.

Interview: This is a technique that involves asking users questions relating to the task just completed. There will be predefined questions for the test participants (see appendix 10). This will be used to determine users' satisfaction with the prototype. The interview session allow test participants to comments on some of the difficulties observed during the testing session and also to express their opinions of the whole test session, thereby making it possible to obtain information about users' levels of satisfaction with the prototype.

According to Nielsen (1994), the best result of any usability testing can be obtained by using combination of several usability techniques.

Test Participants

According to Rubin et.al (2008), a minimum of four to five test participants is needed to expose as many usability problem as possible in a short time. In selecting the number of test participants, certain factors had to be considered: the number of available resources to set-up and conduct the test, the types of test participants required and the duration of the test. It is important to balance the number of test participants with practical constraints of time (Rubin & Chisnell, 2008).

For this testing session, I will be using six ITC students from various departments and these test participants are classified into two groups. The first group of test participants consists of students with little or no knowledge of maps for retrieval and visualization purposes. The second group of test participants includes students with knowledge of maps; either has used maps for retrieval and visualization of data or have worked with maps for other analysis purposes. The major reason for this distinction is to compare the methods and approaches taken by the two groups of test participants in the retrieval and visualization of spatio-temporal statistical data.

Test Environment

The test session will be carried out in the usability laboratory on the first floor of the ITC building. This laboratory, which was setup in year 2000, is equipped with a professional analogue SVHS video camera, for making the video recordings of the sessions and external microphones, to improve the sound system. The laboratory also has computer system, for test participants to carry out the required tasks. Finally, the room is also fitted with a digital quad unit, which allows for the synchronization of the video signals of the test participants, a screen logging from the computer monitor and audio signals and all can be seen together on a television screen (see figure 3.13) and a video recorder player to analyze the output of the testing session. The recording devices are needed not only for analysis purposes, but it also provides a scientific proof of what actually occurred during each test session.

Scenarios and tasks

The test participants will be expected to answer questions given to them along with the prototype. Test participants will also be asked to say out their thoughts as they execute the task and these will be recorded.

Methodology (Researcher's scenario)

I will read the introductory note to the test participants. This note covers the following steps of the test scenario:

1. I will welcome the test participant (5 mins).
2. Explain the aim of the prototype evaluation:
3. I will tell the test participant aim of my research.
4. I will tell the participant the purpose of this usability testing is to evaluate the effectiveness and efficiency of the developed prototype and also users' satisfaction in the retrieval and visualization of spatio-temporal statistical data using the prototype.
5. I will ex plain that all information is confidential.
6. I will briefly explain what the technique use is about and ask them to say their thoughts out loud and what they are doing.
7. I will tell the test participant that the think aloud is about.
8. I will explain and ask the test participants to say their thoughts out loud while doing the tasks.
9. The test will be timed and estimated time of 4 mins per task.
10. I will give the test participant the first questionnaire to fill, while I open the prototype.
11. I will ask the test participants to browse briefly though the prototype for about 3 minutes and then, I will give the task, which also include some form of questionnaire to the test participants and allow them 2 minutes to read and understand the task and if they have any questions, answer them, and then I will leave them to the task. This is to allow the users to have a feel of the methods of dissemination available on the prototype as well as an opportunity to let them know that some buttons are not working but necessary to be included in the prototype to create a feel of a complete NSO website.
12. I will tell test participants to answer the question when necessary, in sheet given to them.
13. Each test participant will be timed. The test is expected to last for 20mins.
14. I will interview test participants after the test. (10 mins)
15. I estimate 40 minutes per test.

Prototype URL on ITC server
http://itcnt07/~alaba20470/final_prototype/home.html

Appendix 13

Overall Researcher's impression

TP1

The TP was able to navigate through the prototype to retrieve the correct map. The test participant was confidence although she had problem of speaking in English.TP1 was not able to express herself properly. She also had no idea of the country. TP1 was not able to initially solve the task 1.Then going back to task 1.TP was able to carryout the task by selecting Lagos and Kano the second time around. TP was still able to finish all tasks within the estimated time frame. TP, although was not very fluent in expressing herself.

Overall TP answered all questions and in good time.

TP2

The TP is an MSc student of the GFM department. TP has knowledge of the use of maps for retrieval of data. TP was able to retrieve data and complete the task successfully

TP3

The TP is a master student of the GFM department. TP has no knowledge of the use of maps for retrieval of data. He has no knowledge of what interactive or animated maps are and I had to tell him. The TP could understand the titles of the maps but could not really relate it properly to which data and how to use it. TP appears to be in a hurry to finish, so did not look through the prototype properly even though he was told by researcher to relax and he will not be stopped even when he uses more time.

TP commented, "When I start with the prototype and the task at first, it was not easy to use because I don't know about maps but when I started and got use to it, it was very simple. I could easy know where to go". TP was not able to see difference in the absolute population map because he forgot that the maps are interactive and he commented" it is not easy to compare for two years".

TP4

The TP first browsed briefly through the prototype and then started the tasks. The TP used the tabs on the menu bar and also the buttons for navigating through the prototype. For the question 2 and 3, I opted for the first method I saw. Looking at the choropleth map, it is very easy.

TP 5

The TP was not conversant with mps and used the wrong map for the task although she realized it and corrected the mistake. TP was really satisfied with methods on the prototype.

TP6

Although TP claimed to be good with maps, she could not really distinguish differences between absolute and pop density. The researcher had to intervene to point out the differences to TP. Having pointed out the differences, TP was able to complete the tasks successfully.

TP7

The TP showed knowledge of maps and understanding of the questions. The TP was confidence and relax in carrying out the task although had to be prompted many times to speak out loud.

S/No	Task	TP1	TP2	TP3	TP4	TP5	TP6	TP7	Summary
1	Suppose you want to know where most people live in the Northern part of Nigeria, by state distribution in 2 different years. Is it possible to find the state(s) with the largest number of inhabitants in the Northern part of Nigeria for the years 1999 and 2005? • Please Tick: Yes No • Please write the name of the state(s): • What method(s) did you apply to answer this question above? Please state	Not map user TP was able to carry out the task. "This is good. I can see the largest state immediately ". Yes Kano and Lagos Proportional symbol map	Average map user TP was able to carryout the task. "I can see the growth in Kaduna state". Yes Kaduna (although not the largest but one of the largest). Proportional symbol map	Not map user TP was able to carry out the task. "It was easy to find the answers". Yes Kano, Jigawa Proportional symbol map	Average map user TP was able to carry out the task. "I can see where most people live and it is kano". Yes Kano Proportional symbol map	Not map user TP was able to carry out the task. "I can see where most people live in Northern part of Nigeria and it is kano". Yes Kano Proportional symbol map	Average map user TP was able to carry out the task. "It was very easy to see the largest growing population in the north." Yes Kano, Sokoto Proportional symbol map	Average map user TP was able to carry out the task. Yes Kano, Lagos Proportional symbol map	The task was successfully completed by the entire 7 test participants.
1b	Task rating: Time: Status:	3 3.35 Correct	2 3.50 Correct	2 2.53 Correct	3 4.05 Correct	2 5.21 Correct	1 3.02 Correct	2 3.35 Correct	Total=26.21/7 =3.46

	Method used:	Proportional symbol map	Proportional symbol map	Proportional symbol map	Proportional symbol map	Proportional symbol map	Proportional symbol map	Proportional symbol map	
2a	Let us consider population density now (number of inhabitants per km2). Are there differences in the changes of population density in the period 1999-2005 between different parts of the country? • Please write the name and population • What tool(s) did you apply to answer this question above? Please state	TP was able to answer the question. "I am able to see the population density for the country". Niger <50 Choropleth map	TP was able to answer the question. "There are many changes in the North and south". Choropleth and multiple static maps.	TP was not able to complete the task correctly. This was due to using the wrong map. Percentage change population density map.	TP was able to answer the question using table. Then later using the choropleth, TP said it was very easy. "I had to depict the answer from the data". Correct Table and choropleth map.	TP was not able to complete the task correctly, although she later discovered and corrected the method chosen. "I choose the wrong method". Correct Percentage change population density map and then choropleth.	TP was not able to complete the task correctly Incorrect Proportional symbol map	TP was not able to complete the task correctly Incorrect Percentage change population density map.	Only 3 participants completed the task successfully.
2b	Task rating: Time: Status: Method used:	1 2.16 Correct Choropleth map	2 4.02 Correct Choropleth and the multiple	3 1.49 Incorrect Percentage change population	4 and 1 4.50 Correct Choropleth and table	2 3.55 Incorrect Percentage change population	1 1.50 Incorrect Proportional symbol map	2 2.56 Incorrect Percentage change population	Total=21.38/7 =3.05

			static maps.	density map.		density map.		density map.	
3a	Please consider population density (number of inhabitants per km^2). Are there differences in the changes in the population density in different parts of the country in the period 1999 to 2006? • Please comment • What tool(s) did you apply to answer this question above? Please state	"Yes you can see the changes by using the button and you see different years and the changes". Choropleth	"Yes, you can see changes in the colors as the year's changes and by clicking the map, u see different data". Choropleth	"Yes there is change in population ". Choropleth	"There is increase in density population for different states and different years". Choropleth and table	"I can see changes". Choropleth	"In the south-east, it was easy to see the pop increase in Enugu and in the west, in Oyo". Choropleth	"The changes were clear to identify". Multiple static map	All test participants completed the tasks successfully.
3b	Task rating: Time: Status: Method used:	1 2.17 Correct Choropleth	1 2.39 Correct Choropleth	2 1.33 Correct Choropleth	2 2.06 Correct Choropleth and table	4 4.35 Correct Choropleth and multiple static maps.	2 4.00 Correct Choropleth	1 2.51 Correct Multiple static map	Total=20.1/7= 2.52

4a	For 1999-2001 and 2005-2006, is it possible to determine percentage change in population density for states in the country? • Please Tick: Yes No • Please, mention few states and estimate their percentage changes in population density	Yes. "It is possible to see the percentage change. I compare the two percentage change maps". Sokoto:-8.28:-4.9, Bayelsa:40.01: 62.50	Yes. "There are various percentage changes for different regions on the two maps 1999-2001 and 2005-2006. There is difference and it can be comparable". TP looked at Oyo and Niger, and compared the changes using the legend. Oyo:2.4%, Niger: 2.2%.	Yes. "There are changes in percentage change in population density". Borno:6%, Yobe: 2%, Bauchi:-7%	Yes. "Yes, it is possible by looking at the legend". Kaduna: 4.89% - 5.89%	Yes. "Yes, it is possible and clear base on the definitions of the maps" Bayelsa:40.01-62.50,19.22-31.031, kano: 5.90-12.42,14.63-19.21	Yes. "I can see differences in the two years for different part of the country by looking at the map and using the legend." Akwa-Ibom:5.90-12.42,Gombe: 40.01-62.50	Yes. "I can see changes and it is very easy". Delta:1.80-7.28, -4.89-5.89	All test participants completed the tasks successfully.
4b	Task rating: Time: Status: Method used:	1 2.45 Correct Percentage change map	2 4.02 Correct Percentage change map	2 2.29 Correct Percentage change map	3 2.55 Correct Percentage change map	2 3.07 Correct Percentage change map	1 2.31 Correct Percentage change map	1 3.43 Correct Percentage change map	Total=21.32/7=3.05

5a	Using the absolute number of population map per year, do you see differences in the rate of change between different parts of the country? If so, please describe these regional differences. • Please Tick: Yes No	"It is possible to see changes". TP was able to see different changes over different states by clicking on the maps. Yes	TP compared the two maps and was able to see the changes. "I clicked on the interface for the given years and I can see the changes". Yes	"There are no differences if you want to compare two different years but you can see the differences between different regions in 1 year". No	Yes, this gives a good idea of how the population is changing in the country by looking at the sizes of the balls". Yes	"There is less change in the northern part of the country". Yes	"There is change in population in the northern part of the country to the southern parts." Yes	"I can see differences by looking at sizes of some places and the clicking on it." Yes	6 of 7 test participants could see changes.

5b	Task rating: Time: Status:	1 3.15 Correct	1 2.25 Correct	2 2.18 Incorrect	2 2.49 Correct	2 2.50 Correct	1 2.59 Correct	2 1.43 Correct	Total=18.19/7 = 2.37

Transcribed data of the interview and data analysis

QUE		TP1	TP2	TP3	TP4	TP5	TP6	TP7	Summary
1	As a user, are you satisfied with the methods of dissemination, retrieval and visualization of spatio-temporal data in the prototype?	TP was satisfied but would prefer to work more with the prototype." I think the prototype is very good".	TP commented, "with my knowledge of maps and website for data I have come across, this is the most user-friendly because what u need u get and the links are clear.	I can't say I am satisfied doing the task because I didn't have time to use it but looking at it, it is very nice and it gives me the information and the maps are very satisfying. I think it is satisfactory for dissemination, retrieval and	I am not totally satisfied because I will prefer a better interface with slide role, and the interface should be multiple functions. But taking the map for dissemination, retrieval and visualization of spatio-temporal	Yes, it is very satisfactory and I can use it for my research or work purpose. This is because I can easily get the information that I need.	I am satisfied with the prototype because of the easy navigation on the prototype to the different methods and the interactivity of the maps.	Yes I am satisfied with the methods on the prototype.	Based on the comments of test participants, all participants were satisfied with the prototype.

				visualization.	data. Yes I am very satisfied.				
2	Were the methods in the prototype sufficient for the execution of your given tasks?	Yes, it was sufficient.	It is very sufficient for me, only the calc. of the percentage but it was not really needed.	The methods are sufficient because I answered all the questions and there are also other methods like tables but I didn't get to use it.	The prototype is sufficient for answering the tasks given.	The prototype is enough for me to answer all the given tasks.	Sure. I was able to go through the maps and answer the questions given using the methods.	The methods are sufficient for answering the questions given.	For all tasks, except task 2, all participants were able to complete the given tasks within reasonable time limit and using different methods.
3	Why were the selected methods for tasks 1, 2 and 3 selected and not the other tools?	I selected the first map I thought would answer the question, based on the question.	Why combine the map and the focus was more on the multiple? TP commented, because it gave me a clearer picture of what I wanted to know". I look at the title and it is clear and I am able to retrieve the data by clicking".	I selected maps based on the years I needed.	The maps are selected based on the first thought that came top my mind and the fact that I had no previous experience with the interface.	I selected the methods based on my understanding of the question and first look very well at the prototype before selecting the method.	The questions were direct and with the titles of the maps, I could easily get the required answers.	The maps were chosen based on the questions and title and the visual display of the maps.	Most methods were selected based on the well defined titles of the maps and the task given.
4	Overall, do you think the prototype was sufficient for	It was very good for carrying out the task and the	I would have preferred to spend some	Yes, the prototype is sufficient,	It is good and visualization is very good. The	The prototype was sufficient and in short time	It is very sufficient. The colors, legends	Yes, the prototype was very sufficient	All TPs commented that overall, the

	answering all the given tasks correctly and in good time frame?	time was good as well. It is easy to use.	time using the interface and know what methods are on it before carrying out the task. But it is still sufficient.	provided we have time to get use to the interface. I would have preferred to spend some time using the interface and know what methods are on it before carrying out the task.	legends are clear and the titles are well defined for each topic.	too. If my answers are correct.	and interactivity helps and it made it possible to spend less time and still answer the questions.	for completing the tasks.	methods available on the prototype were more than enough to solve all the questions asked.
5	How does the animation help in for visualization purpose	It is good to visualize the data because you can see the change in size of the data but the interactive is very important to retrieve the data.	Initially, I didn't get the picture of the data but after using it more than twice, I could understand but it requires a bit expertise to understand the concept but for overall, it is easy to see the general increase in distribution of population. I like it.	I didn't notice initially, because it was taking time to grow but looking at it now, it is easy to see the population distribution on the map by the different ball sizes. But I still can't compare it with different years easily. For 1 year visualization, it is very easy and good but when you go forth and	It gives u a perception of the growth. It is very good and helpful for visualization.	The animation gives me the impression and the control animation gives me more information and good impression as well. Yes, it is very good for visualization.	It was helpful in determining the properties and the growth of population. The larger the ball the more populated and vice verse. It was very helpful.	It is very helpful because it helps you to appreciate the changes and growth of population.	6 of the 7 TPs commented on the usefulness and easy of visualization and retrieval of needed information from the animated maps available on the prototype while 1 TP commented on the difficulty of comparing two years, but commented that for a single year, it is very helpful.

				back, it becomes confusing.					
7	Overall impression and comments.	Overall, I would like to spend more time with the prototype before carrying out the task. But it is very good prototype.	The prototype was sufficient in answering and I am very satisfied.	I would say the prototype is very good and easy to use when you get use to it.	Apart from the mentioned needed correction on the interface, the prototype is very easy to use and also useful.	The prototype is really good. For my research, I will use it.	Overall, I really enjoyed working with the prototype. It was easy to use.	Overall, I am satisfied and it is good. It is very useful and easy to use prototype. Maybe pictures of the places can be added as well.	The overall impression of all test participants is that the prototype is more effective and efficient in dissemination, retrieval and visualization of spatio-temporal statistical data than any other website they have seen and they are satisfied with the methods Available on the prototype.

For time calculation

Task	Percentage of completion	Mean time	Standard deviation time	Summary
1	100	3.46		
2	57	2.52		
3	100	2.51		
4	100	3.05		
5	86	2.37		

The estimated time for each task is 4 minutes.
Mean=sum all participants time per task/number of participants
Standard deviation= Sum of time-(sum of time^2)/no of tasks//no of task-1
If 75% of the test participants do not complete the task, then it is not successful.

0= Not Satisfied
1= Satisfied
2= Very Satisfied

Satisfactory Table

TP	Not Satisfied	Satisfied	Very Satisfied
1			Y
2			Y
3		Y	
4		Y	
5			Y
6			Y
7			Y

Effective Table

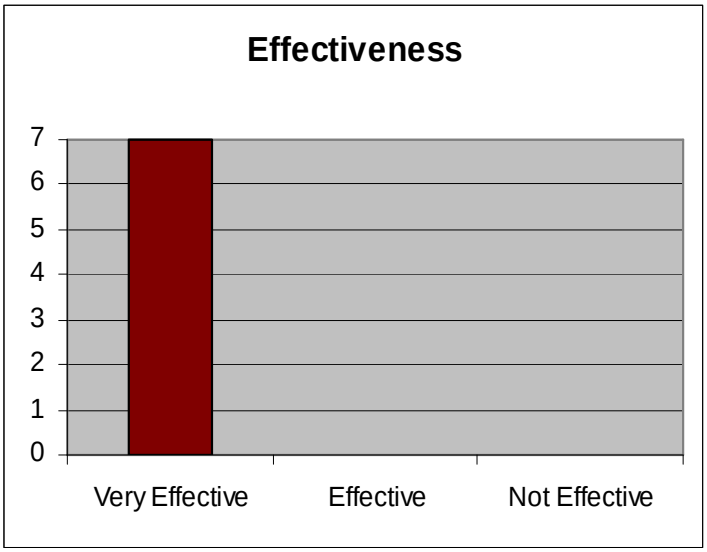
TP	Not Effective	Effective	Very Effective
1			Y
2			Y
3			Y
4			Y
5			Y
6			Y
7			Y

Efficient Table

TP	Not Efficient	Efficient	Very Efficient
1			Y
2			Y
3			Y
4			Y
5			Y
6			Y
7			Y

Satisfactory Table	
Very Satisfactory	5
Satisfactory	2
Not Satisfactory	0

Effectiveness Table	
Very Effective	7
Effective	0
Not Effective	0



Efficiency Table	
Very Efficiency	7
Efficiency	0
Not Efficiency	0