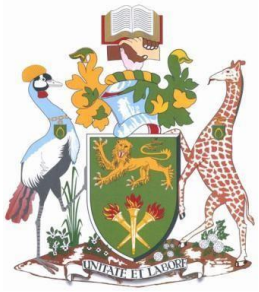


UNIVERSITY OF NAIROBI

SCHOOL OF COMPUTING AND INFORMATICS

Interoperability Framework for National Population Register

A Case Study of IPRS

Moses Onguko Rading

P54/6579/2017

Supervisor

Dr. Elisha Opiyo

A Research Project Submitted in Partial Fulfillment of the Requirements of the Degree of Master of Science in Information Technology Management, School of Computing and Informatics, University of Nairobi.

August 2019

DECLARATION

I hereby declare that this research project is my original work and has not been presented or is due for presentation for any award at any learning Institution.

……. ……

Signature Date

Moses Onguko Rading.

P54/6579/2019

This research project has been submitted for examination with my approval as University Supervisor

…… …….

Signature Date

Dr. Elisha Opiyo,

School of Computing and Informatics,

University of Nairobi.

ACKNOWLEDGEMENT

This project would not have been possible without the backing of many individuals and God. Firstly, I thank the Almighty for the good fortune granted to see me through this course. Sincere appreciation to my project supervisor, Dr. Elisha Opiyo, for the direction and who read several alterations of this report and helped make sense of the entire study. In equal measure, I would as well like to thank all the respondents who took time to fill the questionnaires. It is through their efforts that data was collected for analysis.

Finally, many thanks to my family and numerous friends who put up with the time away from them to work on this study, always offering support and love.

ABBREVIATION AND ACRONYMS

IPRS	-Integrated Population Registration System
PIN	-Personal Identification Number
ID4D	-Identification for Development
MIRP	-Ministry of Immigration and Registration of Persons
CRD	-Civil Registration Department
NRB	-National Registration Bureau
RAD	-Refugee Affairs Department
DOI	-Department of Immigration
ID	-Identification
PRA	-Primary Registration Agency
NPR	-National Population Register
ODIHR	- Office for Democratic Institutions and Human Rights
UIN	- User Identification Number
DIF	-Decentralized Identity Foundation
IFEG	- Interoperability Framework for e-Governance (IFEG)
RTI	-Right to Information
IPR	-Intellectual property rights
IF	-Interoperability Framework
ICT	-Information Communication Technology
EIF	-European Interoperability Framework
EU	-European Union

SOA	-Service Oriented Architecture
IT	-Information Technology
CRVSS	-Civil Registration and Vital Statistics System
SIF	- Semantic Interoperability Framework
NIF	- National ICT Interoperability Framework (NIF)
eGIF	- Greek e-Government Framework and Interoperability Standards for Greek
GSB	- Government Service Bus
EDA	- Event-driven architecture
SME	- Small and Medium-sized enterprises
IMM	-Interoperability Maturity Model
FEA	- Federal Enterprise Architecture
EA	-Enterprise Architecture
SPSS	- Statistical Package for the Social Sciences
BPR	-Business Process Engineering

ABSTRACT

The Government of Kenya has several different agencies all undertaking population registration functions under independent pieces of legislations. The IPRS department has the sole responsibility of hosting the National Population Register by consolidating the data from the population agencies and uniquely identifying each person's data with a unique PIN.

The components of registration/identification systems in Kenya have traditionally functioned in silos, each with its specific mandate. This being the case, integrating these datasets into a common single registry and identified with a unique PIN as required in the National Population Register, has been characterized with interoperability issues.

The purpose of this study was to formulate an interoperability framework that will steer efficient co-ordination, linkages of registration systems and information flows to oversee an ideal status of the National Population Register in Kenya.

The design method adopted was a descriptive single case study. The unit of analysis was the National Population Register as hosted by IPRS.The data which was collected helped in generalization of findings to all case scenarios of National Registers. The unit of observation was interoperability of National Population Register with respect to persons registration departments. For this study, a sample of 94 was arrived at. Stratified random sampling method was adopted for the selection of the study participants. The study used a questionnaire for collection of primary data. Data analysis was done with the help of a statistical analysis program. Descriptive statistics was obtained from the study's variables and this information was presented in cumulative graphs and tables. Both descriptive and inferential statistics were used. Inferential statistics included Cronbach's test that was used to test reliability of data collected, fried man test that was used to test significance conditions within each interoperability factor and z-test analysis that were used to test the significance between dependent and the independent variables.

Validation of the conceptual framework construct by data results, established that technical, semantic and organizational factors had a significant influence on the interoperability of National Population Register in Kenya. The study recommends that interoperability framework be anchored in law as a policy and compulsory compliance to it be enforced.

Key words: Interoperability, National Population Register and PIN.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE INTRODUCTION

1.1 Background to Research Problem

The Government of Kenya has several different agencies all undertaking population registration functions under independent pieces of legislations. These agencies, namely the Civil Registration Department has the mandate of issuing births and deaths certificates. The Department of Immigration has the mandate of issuing passports and alien cards. The National Registration Bureau has the mandate of issuing Identity Cards whereas the Refugee Affairs Department has the mandate of issuing refugee cards. The IPRS department has the sole responsibility of hosting the National Population Register by consolidating data from the four named departments and uniquely identifying each person's data with a 14-digit intelligent PIN Vision 2030, first medium-term plan, (2008 – 2012).

(ID4D,2018), averred that the registration / identification system elements in Kenya have traditionally worked in silos, each with a particular mandate. Unlike nations like Estonia or Netherlands, Kenya doesn't have a single agency to provide identity facilities across the population. This means significant duplication of equipment for registering as well as disjointed information from the different organizations. There is also no distinctive "life number" to identify people from cradle to grave. The solution to this, was the implementation of a National Population Register, which has been bogged down by interoperability issues with feeders of its data.

Disparate population registries have only lately started to develop from paper-based to digital procedures and from paper documents to digital repositories that still need to be scanned and digitized with some significant administrative efforts. Heavy dependence on manual procedures and weak registration of birth and death registrations, have led to interoperability setbacks with the National Population Register, (ID4D,2018).

In its ideal state, the National Population Register, should have all the data from the sourcing agencies in real-time, in its complete, accurate form and the data exchange mechanisms governed by a framework. However, this has not been the case. The data has been characterized by inconsistencies, incompleteness and lack of a data governance framework for information sharing into the master database. (MIRP, strategic plan,2008).

These multifaceted problems existing in the National Population Register have had a negative impact on the Government planning, population surveillance, public administration and formulation of policies, poor service delivery, on-effective utilization of the data by accessing agencies and increased operational costs. Therefore, a need arises for streamlining of the population register processes and enforcing collaborative measures between the registration agencies and the National Population Register, this necessitates the implementation of an interoperability framework to govern the operations and processes of the primary registration agencies and the National Population Register. (MIRP, strategic plan,2008).

The National Population Register is in its early formative years and has integrated data from Civil Registration Department (CRD)-births and deaths, National Registration Bureau (NRB)-ID cards, Refugee Affairs Department (RAD)-Refugee cards and Department of Immigration (DOI)-Passports and Alien cards. In these registration databases, persons are referred with different identification numbers whereas in the National Population Register, a unique intelligent14-digit PIN identifies a person. There is access to the National Population Register by both private and public entities for real-time verification of identity documents. However, there is a gap in the area of data exchange between primary registration agencies (PRAs) and NPR.This is manifested by inaccurate, incoherent, and in some instances complete lack of some datasets, between the primary sources of data and the National Population Register. This impacts on the validity of National Population Register.

1.2 Problem Statement

The components of registration/identification systems in Kenya have traditionally worked in silos, each with their own particular mandate. This being the case, integrating these datasets into a common single registry as required in the National Population Register, has been encountered with interoperability issues.

The service access to the National Population Register has been characterized by complaints in terms of incomplete, inconsistent and complete lack of datasets in some instances by public and private entities. It is not uncommon to find individual records missing, inconsistent dates of birth, lack of certain fields like photos, signature, incorrect order of names et cetera. In some cases there

is variability in datasets, Registry A has different data from Registry B and the same is replicated in the National Population Register.

Some of the registries still have documents in paper-based form, and while efforts have been made to digitize most of these records, the methods used are rudimentary in nature resulting to non-indexed records, hence making integration into the National Population Register a night mare.

Silo mentality and this is "our data", has resulted to reluctant sharing of data to the National Population Register. Registries feel that, if they share their data, they will lose their autonomy, hence they will do anything within their means to curtail free flow of data into the central registry.

1.3 Main Objective

Formulate an interoperability framework that will steer efficient co-ordination, linkages of registration systems and data flows to oversee an ideal status of the National Population Register.

1.4 Specific Objectives

i) To identify the issues and challenges in establishing interoperability and information sharing among population registries into the National Population Register.
ii) To investigate the influence of Technical Interoperability, Organizational Interoperability and Semantic Interoperability with respect to data sources.
iii) To formulate and to validate the framework using an interoperability primary data framework.
iv) To offer a set of specific recommendations that can be adapted by various stake-holders to proactively address the challenges in interoperability.

1.5 Research Questions

i) What are the challenges that affect synchronization of person's data between registration agencies and the National Population Register?
ii) Do Technical Interoperability, Organizational Interoperability and Semantic Interoperability with respect to data sources on National Population Register matter in terms of addressing interoperability issues?
iii) How will the validated framework be part of the solution for interoperability?
iv) How will the offered recommendations be implemented?

1.6 Significance of the Proposal

The research proposal will provide useful insights to Government departments related to population registration and other relevant entities, to adapt to better data exchange mechanisms to National Population Register resulting to better quality of data in the register.

An accurate and up to date National Population Register, will result to an accurate, reliable and comprehensive population registration database, that will contain a unique PIN that uniquely identifies every single individual resident in the country, and will be used in all subsequent population registrations for common identification. Single Version of Truth status, will be achieved.

Kenya being among the few countries that is implementing the concept of National Population Register, it will serve as an eye opener to the rest of Africa and the world.

1.7 Expected Contribution

i) The research findings will inject new knowledge into the body of research about the interoperability of population registries in the formation of the National Population Register.
ii) The interoperability framework adopted, will guide countries that are currently grappling with formation of National Population Registers in addressing the issues that they face in achieving their task.

1.8 Chapter Summary

The Government of Kenya has several different population registration agencies all undertaking population registration functions. These agencies currently feed data into the National Population Register. The identity, alien, refugee and passport numbers are conglomerated into the National Population Register and uniquely identified with a unique PIN. The National Population Register data is granted access to both public and private entities as the single version of truth in identifying individual's resident in the country.

As the data is exposed, they are numerous compliants in terms of data inconsistencies, missing datasets, data formats, data transfer mechanisms, real-time data exchange mechanisms et cetera. All these point into issues in the interoperability space and this calls for implementation of an interoperability framework that can address these issues. Silo mentality also hampers the smooth

flow of data into the population register. Agencies, feel that the data belongs to them and therefore they can't share their data, this hampers data flow into the national register.

Objectives of the project are to identify challenges, study existing interoperability frameworks and identify one that fits the current scenario, use the selected framework to offer recommendations to address the current issues.

The significance of the project is that useful insights will be provided to population registration departments in terms of their processes related to data transfer into the National Population Register. An ideal National Population Register, will uniquely identify Kenyan residents and hence be the defacto Single Version of Truth on its Citizens.

CHAPTER TWO LITERATURE REVIEW

2.1 Introduction

The National Population Register is system that endlessly records personal data of all usual residents, and non-citizens residing in the territory of a nation that meet the provisions for registration as meted out within the relevant legal framework in which a comprehensive identity register is maintained by a competent authority. The population register contains the fundamental identical and demographic information together with biometric templates of the residents of the country. They are often treated as data hubs and connected relevant service delivery initiatives to render. The consolidated data is implemented by different sector specific information that feeds into the central data hub with co-ordinated linkages, so providing updated 360-degree view of an individual. (ODIHR,2012).

Co-ordination of interlinkages to the central population database from sector specific population registration centres is very important as population registers are results of continuous events, within which notifications of registration activities, as recorded originally in several registration systems, are synchronized on a daily basis. Thus, the registers maintain the original characterstics of the individuals.

Each individual during a National Population Register is allotted a singular distinguishing identity (UIN). The NPR are often utilized by registries and social programs, existing and within the pipeline, to verify identity and facilitate the protection and transparency of transactions like payment of social edges. The UNI is the linking ‘key’ across sector specific databases. (ID4D India,2016).

The Integrated Population Registration System, the Kenyan system responsible for hosting the National Population Register.The scheme offers a 360-degree perspective, making it simple for organizations to access the entire registration and identity documents of an individual using a single unique identification number. This makes it possible for digitally connected organizations to authenticate citizens ' records or to recognize Kenyans by combining their biometric and photographic information with any records they have. This has been the corner stone of transactions online. Previously, in terms of credit development, comfort and quick transactions were unheard of. Mobile phone transactions are now taking place. This is the courtesy of the IPRS scheme that makes it simple to check the data of people (The Star Newspaper,2016)

Generally speaking, no nation in the globe has a single source properly reflecting the increasing complexity of the dynamics of demographic growth and migration. A range of information sources, including household studies, boundary statistics, administrative records and other administrative information, generate population and migration statistics of distinct kinds, each with its own strengths and constraints. (United Nations, 2002, p. 9).

Citizen-centric and service-oriented registry systems require computer technologies to function as an integrated whole to support citizens and organisations, to achieve this, different population registries and information systems must be interoperable, or in other words able to work together so that data is requested once from citizens.

Turning Applications by e-government to interoperable alternatives crossing organisational or even domestic boundaries raise the issue of information security. Hence the need to find out which laws and laws in this region of "information sharing of identity associated information" have been placed in place (eSIN,2013)

2.2 Situational Analysis of Kenya's National Population Register

The Government of the Republic of Kenya has several disparate population registration agencies all undertaking population registration functions under independent legislation. These agencies include the Civil Registration Department-Birth Certificates, National Registration Bureau-ID cards, Department of Immigration-Passports and Alien cards, Refugee Affairs-Refugee cards.The National Population Register is formed from the amalgamation of these registries and the population records are uniquely identified by a 14-digit intelligent PIN.

The activities of these registry organizations in inner and external connections are nearly manual, autonomous and deficient. This has resulted to duplication in population information collection and processing, bad delivery of service, and is susceptible to falsification and manipulation.

To address this problem, the Integrated Population Registration System (IPRS) that was to host the National Population Register was expected to develop a policy framework, implement electronic linkages by computerizing the different population registration organizations and the harmonization of the different population registration schemes in Kenya.However,the implementation initiation has been partially achieved.

The objective of the Integrated Population Registration System through hosting of the National Population Register was to provide a common reference framework geared towards facilitating efficient coordination, links between enrollment centres and flows of data. This will also allow users to access Integrated Government Registration Services in a convenient, equitable and innovative manner and encourage interoperability, scalability and safety.

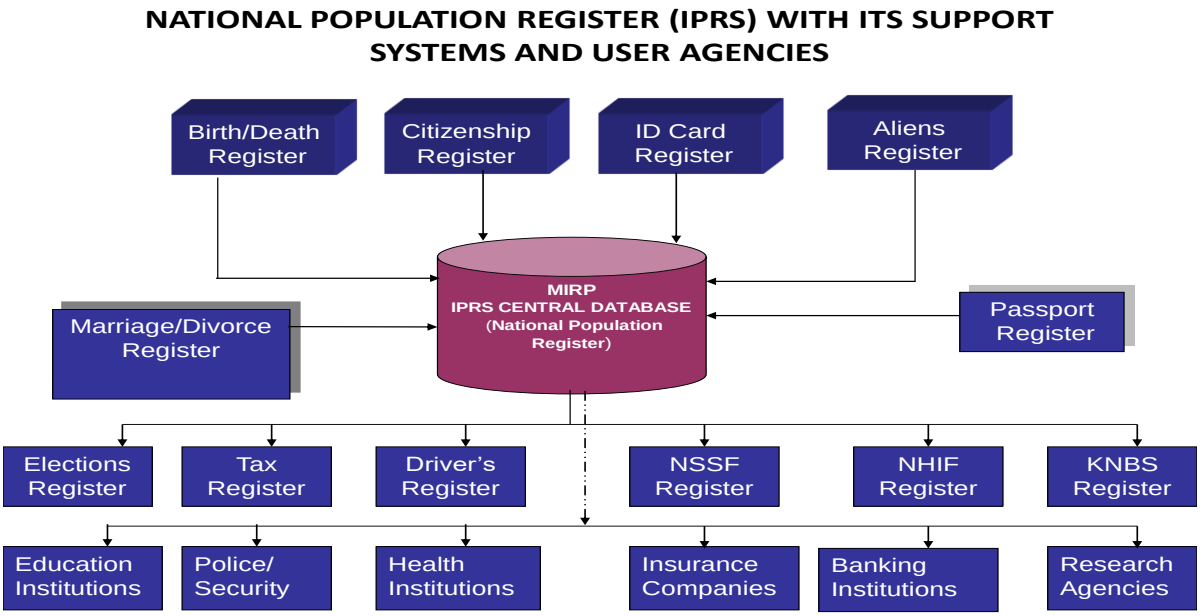


Fig 1: IPRS and its support systems

2.3 Interoperability

Interoperability can be defined as the ability of separate systems to communicate and share information that is semantically compatible, perform compatible transactions and interact in ways that support compatible business processes to enable their users to perform desired tasks. In the context of eGovernment, users may be citizens, businesses or government employees or agencies performing tasks involving government interaction, and any activity or sequence of actions that corresponds to such a task is a business process. An interoperability framework is a collection of principles, policies, criteria, requirements, norms, protocols and procedures designed to serve eGovernment developers in designing, acquiring and implementing systems, information,

semantics, business processes and policies that efficiently, flexibly and meaningfully interact with each other to alter public organisations. (DIF,2011)

Accessibility of information syntactically and semantically from one e-Governance system to another e-Governance system is not easy due to the use of varying formats, structures and meanings. The wide use of different types of data-frameworks, processes & rules, time-bases and user-interfaces in the e-Governance systems make interoperability a difficult task. (IFEG,2015).

Addressing of contrasting-requirements like dissemination of information under legal requirements (like compliance to RTI) and rules related to data protection (like privacy, IPR), sensitivity of data, differences in culture, working practices, issues of trust, timings, collaboration, work-flows, convincing stake-holders, legal issues, levels of political support and technical approach among public agencies may also pose problems for implementing interoperability. Cultural and linguistic diversity in India introduces additional administrative constraints like naming conventions, multiple local official languages, language-dependent format, etc (IFEG,2015)

Electronic government provides a fresh channel through which people, companies, and public organizations can communicate with each other. The provision of eGovernment facilities (e-Services) has the ability to promote such interactions, increasing traditional government channels by allowing unconstrained digital access by the parties ' places and schedules, thereby enhancing the efficiency of the public industry. However, e-Services must be "interoperable" with each other in order to realize this vision: that is, they must be willing to work together, exchanging compatible and meaningful data to help the duties their customers need to undertake. Such interoperability between e-Services should assist decrease public costs, increase its cost-effectiveness, enhance public services ' coherence, consistency, and responsiveness, and eventually enhance democracy by enabling people-government interactions while establishing public itself that is open, The creation of interoperable eServices, stemming from functional, technical, procedural, cultural and semantic differences between public organisations providing these services, presents profound difficulties. One way to meet these difficulties is to build an interoperability structure (IF) to assist eService developers and implementers work smoothly together. (DIF,2012)

Interoperability includes much more than data and communication (ICT) systems alone. Interoperability between ICT systems could be a way to enable agencies, organisations, user teams

(people or companies), municipalities, areas, or perhaps nation states to operate more effectively and effectively with each other. The general objective of interoperability is to enhance these interactions between organizations and society (EIF,2011)

2.3.1 Interoperability and National Population Register

Base registers are reliable sources of fundamental information about people, vehicles, businesses, etc. and are the fulcrum of public services. The EU already has legal instruments promoting the principle of economic and non-commercial re-use of any publicly presentable particulars in base registries, and EU-wide interconnection of interconnection of base registries, starting with company registers. Obtaining this information online reduces administrative burdens. This normally creates a rising demand for this information to be deemed to be just as authentic as the paper versions. The electronic base registries records should therefore be formalized in legislation. (European Commission,2013).

Citizens, land, vehicles and other registries are usually regulated by sector-specific laws, which can be a obstacle to the sharing of digital information across registries by government administrations. Because this possibility are normally not taken into account, the legislation may, probably unintentionally, create conflicts or obstacles to data sharing. Experience shows that where base registries can adopt common data sharing principles, interoperability agreements on governance, accessibility, data quality and ‘once only data provision’ then follow. This not only bridges differences in legislation, but is also a first step towards cross-base registry legal acts (European Commission,2013).

Citizen, land, vehicle and alternative registries are typically ruled by sector-specific legislation, which can be a barrier to public administrations sharing electronic information across registries. As a result of this, underlying issues are not taken into consideration, the legislation might, in all probability accidentally, produce conflicts or obstacles to information sharing. From previous similar events, whenever base registries adopt common information sharing principles, ability agreements on governance, accessibility, information quality and ‘once solely data provision’ is taken care of. This not only solely bridges variations in legislation, it is also a prime step towards cross-base written record legal acts

According, (UN registries,2014), It is a legal and reputational 'must' for government administrations to protect sensitive private information retained in base registries. A baseline is

generally provided by EU data protection and electronic communication laws. Nevertheless, government administrations may still have concerns about data protection when they interconnect their registers, even if there are advantages for people. Working with domestic officials for data security, involving them in the decision-making procedure, monitoring compliance and settlement of disputes, builds confidence. An extra-legal support requirement is needed to verify compliance when interconnecting across boundaries. Furthermore, it makes sense to operate according to the regulations of the European Information Protection Supervisor (EC,2013)

Member registries must be conscious of the technological limitations imposed by specifying proprietary techniques when regulating base registry interconnections. This is likely to result in a maintenance burden for registries and unnecessary costs for public administrations which will find themselves locked into a single vendor, and hence have undesired effects on interoperability. Technology-neutral should be the legal requirements describing the interconnection structure. Nonetheless, if there is a desire to control the technical specifications, then additional versatile legal instruments ought to be used, like 'comitology' selections within the case of the EU(EC,2013).

The major challenge in linking up base registries doesn't relate to style and implementation of technology however to stakeholder buy-in by the data owners. Legislation is likely to be needed to force the use of interconnecting infrastructure and pre-empt proliferating point-to-point interconnections continuously. Stakeholders should participate in the development of laws and be provided sufficient time to prepare for execution. (ID4D,2016).

Building consensus and management are crucial to the achievement of base registry interconnection. A cross-organizational committee with decision-making powers at domestic level enables to accomplish this. The committee's powers is jusridicated to implementing new interconnections between base registries. (ID4D.2016)

Base registries are progressively simplifying access to their information across industries and across boundaries by interconnecting with other base registries using interoperable interfaces for the advantage not only of public, but also of people and companies. Thus to ensure public administrations are aligned with the real business needs of users, they need to collaborate when defining what interoperable interfaces are required. (ID4D,2016)

Interoperability agreements are essential whenever base registries are to be interconnected, to formalize the connection between information provider / consumer and lock in engagement. This will achieve a good health status datawise of the National Population Register. Interoperability agreements should cover organizational (governance), and semantic and technical specification aspects. (DIF,2012)

Engagement of stakeholders should be an essential component of any project to interconnect base registries as the initiative is bound to have a significant organizational effect. It is vital to buy early from registry holders as potential main consumers. The attention of stakeholders needs to be focused on user-centricity, i.e. the most needed services, and the business value, i.e. the interconnection benefits. (EIF,2014)

Semantic interoperability is a major factor, hence it should be looked upon from the digital economy perspective to avoid being an hindrance. Because they developed independently, they use various models for even the most fundamental data, such as first name of a person and family name(s). Base registries will not interoperate cordially unless semantic conflicts are settled. Data format problems (xml, csv, rdf, etc.) are generally readily solved when there are no semantic conflicts. (NORA,2011)

In order to avoid identification duplication, the host of the central register usually assigns one distinctive number to every person, employing a well-defined identification

Schema to avoid unambiguous hence create consistency
These identifiers are necessary within the delivery of public services and in implementing the ‘once-only’ principle for persons. (Vision,2030)

The technical non-uniformity by applying standardized, loosely coupled service components interconnected through infrastructure, this has led from a different development of base registries. Service Oriented Architecture (SOA) is a methodology for implementing this concept and is becoming widespread as it is the default choice to connect base registries (Papazoglou,20005)

Secure exchange of data needs digital certificates, electronic records making use of a digital signature to link a public key (used for example when encrypting a document) with identity information.

2.3.2 The Greece Approach

The government of Greece has the Electronic Government Now (eGov Now) that defines principles and tools for interoperability within the public sector information systems, including large databases and base registries, considered as key modules of electronic government. It also supports other structural elements like interoperability interfaces, etc. Its completion led to better use of existing information in the base registries, by promoting better collaboration between departments, such as. Ministry of Health, Employment Agency, Ministry of Labour, and Ministry of Environment (Greece eGovernement,2015)

Legal interoperability, in the context of base registries, is about ensuring that public administrations in charge of the registries operate under a harmonized legal framework. Thus, the policies and strategies included in the common framework enable base registries to cooperate, resulting in cost and time savings. The Greek e-Government Framework and Interoperability Standards for Greek Public Administration (e-GIF) is regulated in the law. (Greece eGovernement,2015)

For the," Only Once Principle there of Greece". There is, the e-Government Strategy that defines the establishment of the interconnection of basic registries which will result in the reuse of information. The main registers, the Tax Registry, Social Security Registry, Population Registry, Police Identity Registry, Business Registry will be combined, using a common binding standard and will interoperate with each other. The development of new registries or data bases will follow the common standard procedure and will interoperate with the rest. (Greek,e-GIF 2012).

Greece's Civil Status Registry, which is the Central population register, faces issues as a result of lack of common areas, standardization and owing to the still non-electronic nature of many public sector facilities and adherence to common definitions. Moreover, when services are made electronic, usually the existing diversity on data, documents and forms are transferred electronic format, resulting into noninteroperable artefacts. (Greek, e-GIF 2012).

According to the diagram below, the sector-specific registers are linked to the central database by storing the SIN as the primary or foreign key in the corresponding databases and maintaining local identifiers, as well as possible additional data such as a post office box field. This is a situation that suits best from a technical point of perspective and data protection issues with the many distinct IT systems and registers in the public sector. Applications in the industry therefore profit

from core data management with regard to their fundamental address information, for address information, for instance. There is definitely no justification for the concept of a true "single" identity number when distinct autonomous systems exist (Luxembourg,2010)

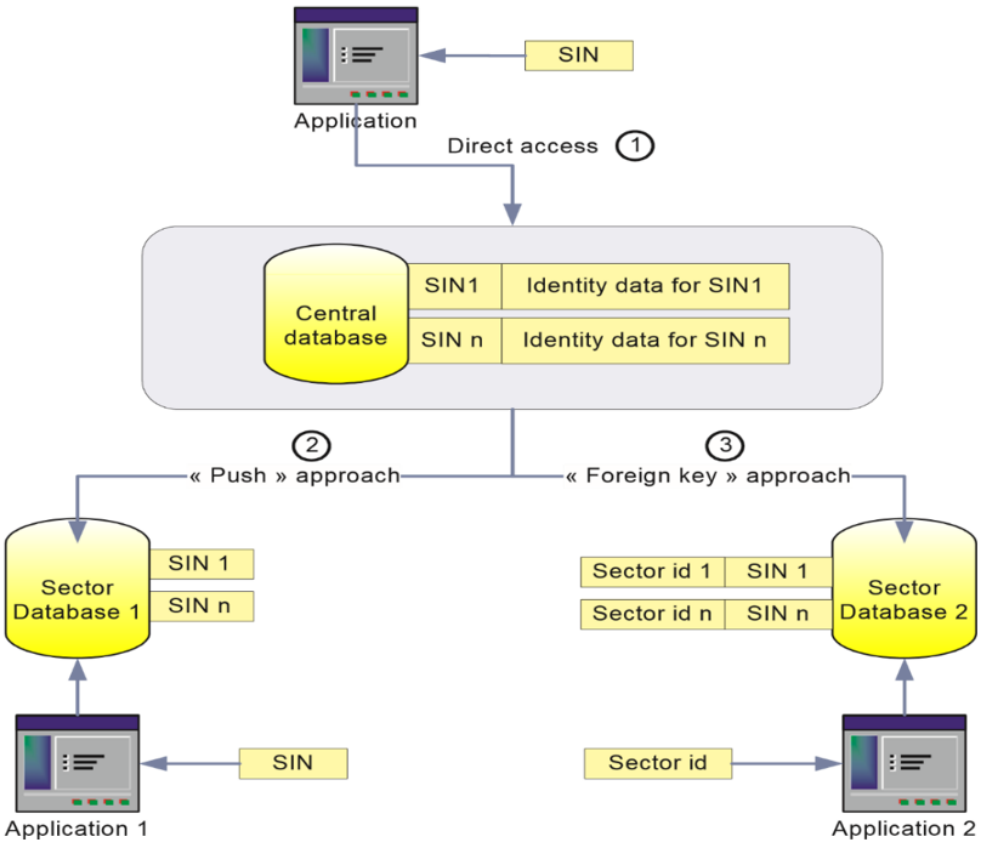


Fig 2: Central approaches to identity management

2.3.3 Turkey's Solution to National Register

Turkey has attained its information collection and updating of its main database by virtually integrating current administrative population registries (interoperability). Data is transmitted through internet services solely. For instance, information transfers between local branches and the ministry are created into the main database through a' safe tunnel' and a virtual private network. The extensive domestic identification scheme of Turkey has given a powerful distinctive

identification for inclusion across demographic registries. Turkey's situation also bears witness to the significant role that political will plays in influencing the design of population inclusion alternatives. The main goal was to share information: two-way flow (Leite, George, Karippacheril, Sun, Jones & Lindert,2017)

2.3.4 Kenya's Case-Birth Certificates

At present the Situation in Kenya, the CRVSS is limited to accepting registration records which are in a specific format and with all data fields completed, or otherwise the record is rejected. This poses a significant barrier to both registration and to populating the IPRS that hosts the National Population Register. A key field is the National ID of parents in birth certificates, this field happens to be missing in majority of the birth certificates hence hampering their transfer into the National Population Register. (USAID,2013)

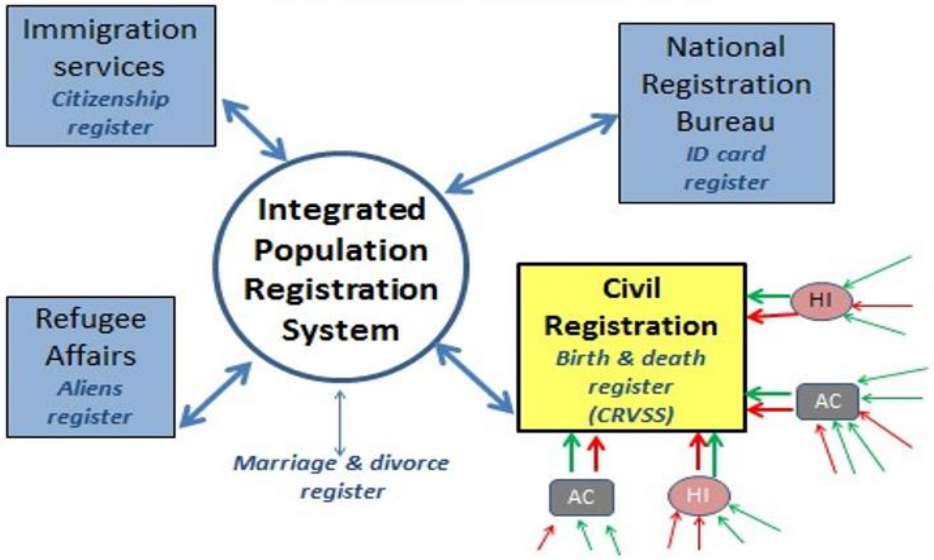


Fig 3: Kenya's Civil Registration

2.4 Interoperability Frameworks

2.4.1 Interoperability Framework for e-Governance (IFEG) in India

GoI seeks to make all government services digitally available to people via various channels, such as internet, mobile and common service distribution outlets, under Digital India's overarching vision. To achieve this goal, there is a desire for an interoperable system of information, applications and processes that will at the right time make use of the correct data for the right user. Write down anything you want. To paraphrase it, click the Quill It button on the right. In this context, it is important to ensure interoperability amongst various e-Governance systems to upgrade the quality and effectiveness of service delivery. Without the assurance of interoperability, citizens will have fragmented interactions with several agencies. These largely uncoordinated interactions with limited coherence will significantly degrade the quality and service delivery efficiency contrary to the Government of India's (GoI) vision and intent.

Currently, the citizen has to interact with more than one public agency to avail a service. Most of the e-Governance systems and databases are established in silos as per the specific requirements of the individual public agency. These public agencies have limited coherence and interactions remain largely uncoordinated. Interoperability among these systems is one of the most urgent and important challenges.

There are three main objectives in any interoperability scheme (computer or otherwise) to achieve interoperability.

Data exchange through Infrastructure and Software: technical capacity of software / hardware used by distinct devices for data exchange through popular data exchange protocols, software development needed for information connection management, creation of user interfaces to allow interaction between distinct organizations.

Significant exchange: Ability of distinct systems / organizations to comprehend exchanged information in the same manner through a mechanism enabling service information and information definitions to be presented.

Process Agreement: Ability of organizations to provide services to other organizations or their customers, Securing service contracts and legalizing them.

E-Governance Interoperability Framework: IFEG in the Indian context would include an accepted strategy to be implemented by government organizations wishing to work together towards the joint delivery of public services using ICT to accomplish the above-mentioned objectives, namely information exchange, information exchange significance and agreed process.

Levels of Interoperability

The level of interoperability linked to data sharing in IFEG is primarily categorized as:

Organizational interoperability: re-engineering of processes, including government orders, process changes, organizational structures.

Semantic interoperability: enabling the interpretation and processing of information with the same significance, etc..

Technical interoperability: technical problems related to the interconnection of ICT devices and services, data storage and archiving, data exchange and networking protocols, safety, etc.; technical interoperability has generally been regarded for the classification of norms into different layers or domains: e.g. Domain of presentation, network domain, domain of data interchange, etc.

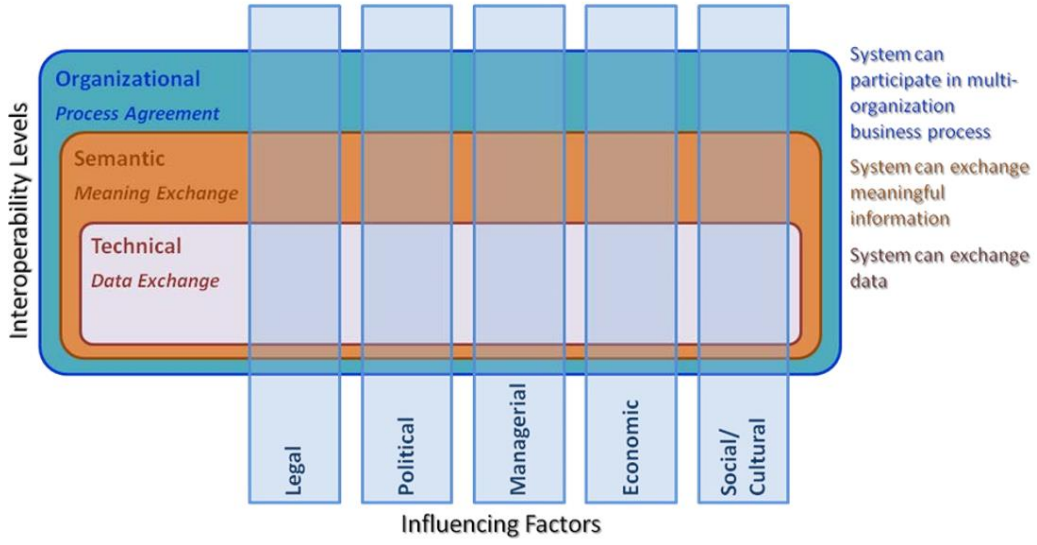


Fig 4:e-Governance Interoperability Framework

The Multilateral mechanism for IFEG is influenced by the following key sub-areas:

i) Political – For strategy related issues. In Political context, support and commitment from authority, provisioning of policies / guidelines, strategies over different levels of interoperability are expected.
ii) Legal–Issues such as IPR / Copy Right, Content Regulation, Privacy, Information Freedom, Electronic Identity, etc. Legal variables include legal power allocated to the Citizen's Data Protection and Privacy Information System, information management governance problems, e-governance executive orders and regulations, administrative-driven citizen services, enforcement, etc. Managerial – For issues like training, motivation, reorientation of concerned staff from public agencies.
iii) Economic – For funding related issues.
iv) Social/Cultural – For social/cultural characteristics of system stakeholders. Social / Cultural factors like differences in culture, working practices, issues of trust, timings, social exclusion issues have more influence. Cultural and linguistic diversity in India introduces additional administrative constraints like naming conventions, multiple local official languages, language dependent format, etc.
v) When an e-Service initiative involves more than one public agency, there is a need for a commonly agreed project plan before committing a budget for the initiative. Clear-cut roles, responsibilities and accountabilities of all stake-holders should be defined and maintained. Also, adequate organizational resources should be provisioned and capabilities for implementing IFEG should be imparted through capacity building.

Interoperability Levels:

Organizational Interoperability: Organizational Interoperability enables a multilateral mechanism to ensure proper management and implementation of IFEG by identifying and addressing any possible barriers: including legal, political, managerial and economic. Multilateral mechanism means organizational structures, appropriate processes, adequate resources, facilities, autonomy and authority.

Semantic Interoperability: Semantic Interoperability addresses the requirement of understanding the meaning of data by different stakeholders in same way, while exchanging data. The purpose

of Semantic Interoperability is to build the capability of all stakeholders involved in the delivery of e-Services.

Technical Interoperability: To knit different kinds of e-Governance infrastructure and their services together through a catalogue of technical standards and specifications for the purpose of achieving interoperability in e-Governance systems; this is done by exchanging information across various boundaries: applications, interfaces, libraries, levels of administration including vertical and horizontal, etc.) and storage/archival of the information.

This framework concentrates on user identification standardization, standardization of processes, information ownership matrix, process agreement at the organizational level. At the semantic level, remedial measures include: semantic interoperability framework (SIF) and domain specific metadata standards whereas at technical level, success factors to be considered include: standards to enable technical interoperability, integration with legacy applications and service-oriented architecture.

2.4.2 European Interoperability Framework

Member States of the European Union have a series of liberties guaranteed by a series of policies backed by interconnected, interoperable networks and systems. Union residents are free to work and move and companies in all EU Member States are free to trade and function. Consequently, they inevitably have to relocate with government administrations of Member States electronically. Member States are modernizing their government administrations by implementing digital government facilities in order to make these interactions economically, efficiently, timely and of the highest quality, and to help cut red tape and reduce the cost and power involved. In doing so, however, they risk creating isolated digital environments and subsequently electronic obstacles that prevent government administrations from linking with each other, and identifying and misrepresenting digital public services in nations other than their own. Therefore, attempts to electronize the overall public sector should be coordinated at European and national level in order to prevent digital fragmentation of services and data and to promote the smooth functioning of the EU's digital single market.

At the same moment, the difficulties confronting the Union require common policy reactions from Member States and hence the Commission, through EU laws requiring cross-border communication and across policy industries.

This also includes setting up interoperable systems and operating them. Such systems are designed to guarantee efficient communication between digital elements such as machines, networks and information repositories, as set out in the Digital Single Market Strategy. They also provide more effective cross-border links, between groups and between government and government facilities. This also includes the installation and operation of interoperable devices.

The EIF provides advice to government administrations on how to enhance the governance of their interoperability operations through a set of suggestions, create cross-organizational partnerships, streamline procedures that support end-to-end digital service

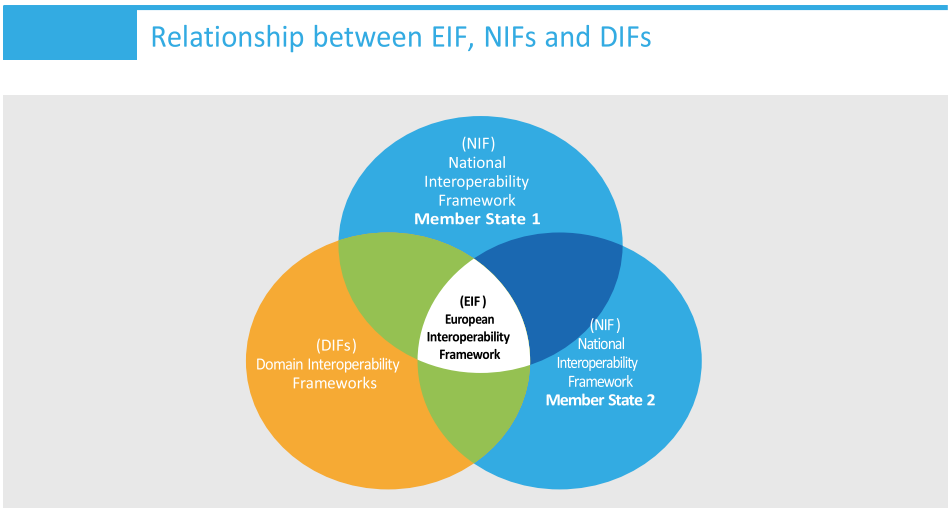


Fig 5: Relationship Between EIF,NIFs and DIFs

The EIF generally gives value in two ways:

i) Bottom-up: when the NIF aligned with the EIF is used to implement government services at all levels of domestic administrations, it generates the circumstances for interoperability in order to extend the scope of these services across boundaries; •

ii) Top-down: when the EIF is regarded in EU laws and policy areas, either through ad hoc references or more structurally using DIFs, it reduces the scope of these services. In each case, the resulting effect of the European public service system in which system owners and system and public service designers become attentive to system-to-system intercommunication.

iii) Requirements, government authorities are able to cooperate with each other, companies and voters, and information flows across boundaries to promote Europe's digital single market.

In each case, the resultant effect of the European Public Services system in which system owners and designers of systems and public services become attentive to intercommunication among systems

Interoperability areas

The range of the EIF includes three interaction kinds:

• A2A (administration) referring to relationships between government administrations (e.g. Member States or institutions of the European Union) ;

• A2B (company administration), referring to relationships between government authorities (in a Member State or an EU institution) and companies ;

• A2C (Citizen Administration), referring to relationships between government authorities (in a Member State or organization of the EU) and citizens.

It emphasizes values of interoperability such as subsidiarity and proportionality, openness, accountability, reusability, technology neutrality and information portability, user focus, integration and availability, safety and privacy, multilingualism, simplification of administration, data preservation

Interoperability Framework

This defines a framework for interoperability that applies to all digital public services and should even be considered as an essential aspect of the interoperability-by-design paradigm. It involves:

i) Four interoperability layers: legal, organizational, linguistic and technical.;
ii) Cross-sectional component of the four layers, ' integrated governance of the public service ' background layer, ' interoperability governance '
iii) Background layer ' Governance of Interoperability '

The structure is as shown below:

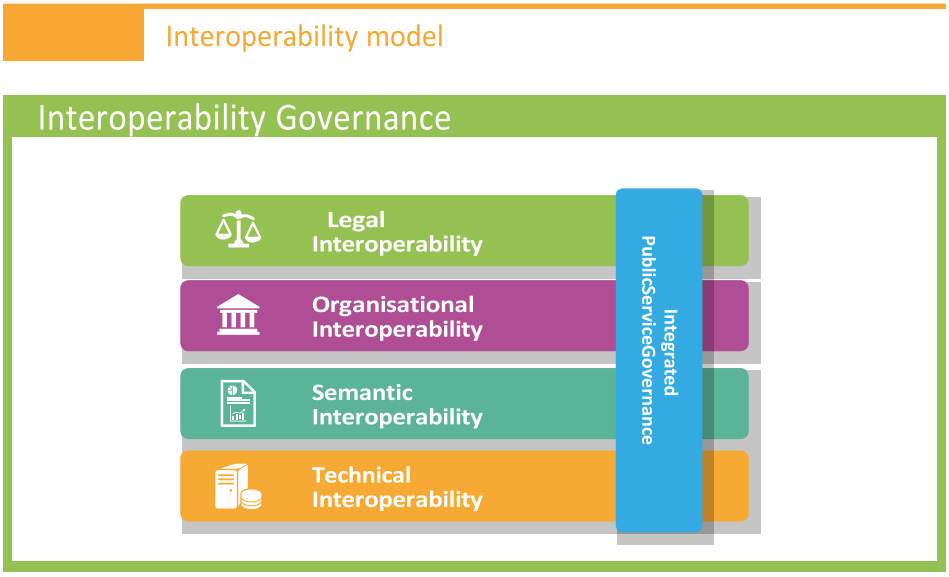


Fig 6: Interoperability Model

Interoperability Governance

Interoperability governance relates to choices on interoperability frameworks, organizational arrangements, organizational structures, roles and duties, policies, treaties and other elements of domestic and EU level ensuring and tracking interoperability.

Governance of interoperability is the key to a holistic approach to interoperability as it brings together all the tools required to implement it. Establish procedures for selecting and evaluating

appropriate norms and requirements, monitoring their application, monitoring adherence and testing their interoperability.

Governance of interoperability relates to decisions on associated frameworks, institutional arrangements, organizational structures, roles and duties, policies, treaties and various aspects of determining and observing capacity at domestic and EU level.

Interoperability governance is a key to a holistic strategy to interoperability, as it brings together all the tools needed to use it. It also inserts processes for selecting appropriate norms and requirements, assessing them, monitoring their execution, monitoring adherence, and examining their capabilities.

Integrated public service governance

The provision of European public service often requires separate government authorities to work together to satisfy the requirements of end-users and to provide integrated public services. There is a need for coordination and governance by officials with a mandate to design, implement and operate European government facilities when various organizations are concerned. Services should be regulated to guarantee: inclusion, seamless implementation, reuse of services and information, and creation of fresh services and' construction blocks.' Ensure interoperability and coordination over time through the establishment of the required governance structures when running and providing integrated public services.

Legal interoperability

Each public administration that contributes to a European public service operates within its own domestic legal framework.

The aim of legal interoperability is to ensure that organizations operating under distinct legal frameworks, policies and techniques are prepared to work together. This could involve that law does not block the establishment of European government facilities within and between Member States and that there are clear agreements on how to cope with variations in cross-border laws, including.

Organizational Interoperability

This relates to how government authorities align their company procedures, duties and expectations to generally achieve united and mutualistic objectives. In fact, the capacity to organize subscribes to document and integrate or position business processes and shared appropriate information.

Semantic interoperability

Semantic interoperability guarantees that the accurate format and significance of data and information exchanged are maintained and understood throughout the exchange between parties, in other words' what is sent is what is understood.' Semantic interoperability includes semantic as well as syntactic elements in the EIF.

Semantic interoperability ensures that the precise format and usefulness of the shared information and data is preserved and understood throughout exchanges between parties, that is‘ what is distributed is what's understood'. In the EIF, semantic interoperability covers both semantic and syntactic aspects.

Technical Interoperability

This includes the technologies and services connecting apps and infrastructures. Technical interoperability aspects include interface requirements, interconnection services, facilities for data integration, data presentation and exchange, and safe protocols for communication. Legacy systems constitute a significant barrier to interoperability. Historically, applications and information systems in public administrations were developed in a bottom-up fashion, trying to solve domain-specific and local problems. This resulted in fragmented ICT islands which are difficult to interoperate. Due to the size of public administration and the fragmentation of ICT solutions, the plethora of legacy systems create

2.4.3 e-Government Interoperability Framework for Mozambique

Harmonizing decentralized ICT alternatives with centralized policies, such as encouraging resource reuse and optimization, is a complicated technical and organizational challenge facing many governments. The issue is also becoming a concern for Mozambique, which has lately begun to introduce its ICT policy and for which it is now apparent that - if no specific attention is paid to

the interoperability of the alternatives being created-the outcome will quickly become a patchwork of ICT alternatives incompatible with each other.

Achieving interoperability between eGovernment projects is a key milestone in enhancing efficiency and efficiency

The approach

The dangers and possibilities affecting Mozambique needed a structure to refine current strategies to be adapted to Mozambique's particular requirements and limitations. Therefore, eGIF4 M is based on the following key actions: technical implementation, organized in two key areas:· Implementation of an architectural framework— the eGIF4 M service delivery architecture — on the basis of a public service bus, where all systems fit into interoperability.

Organizational implementation

Structured in: Definition of a framework for interoperability maturity that measures the level of eGIF compliance and implementation. This data is crucial for quantifying and making eGIF's advantages (or disadvantages) visible and can be used as an significant instrument for setting up incentives for more virtuous initiatives.

Technical implementation

In this section, we discuss the details of eGIF4 M technical implementation, including I service delivery architecture, (ii) data formats, (iii) architecture mapping of standards / data formats, (iv) documentation and development standards, and (v) eGIF4 M service delivery architecture standardization lifecycle Figure 4 describes eGIF4 M service delivery architecture. The architecture is based on a Government Service Bus (GSB) of 13/77 and follows the normal approaches to SOA (service-oriented architecture) and EDA (event-driven architecture), see the

Appendix forve levels and industries.

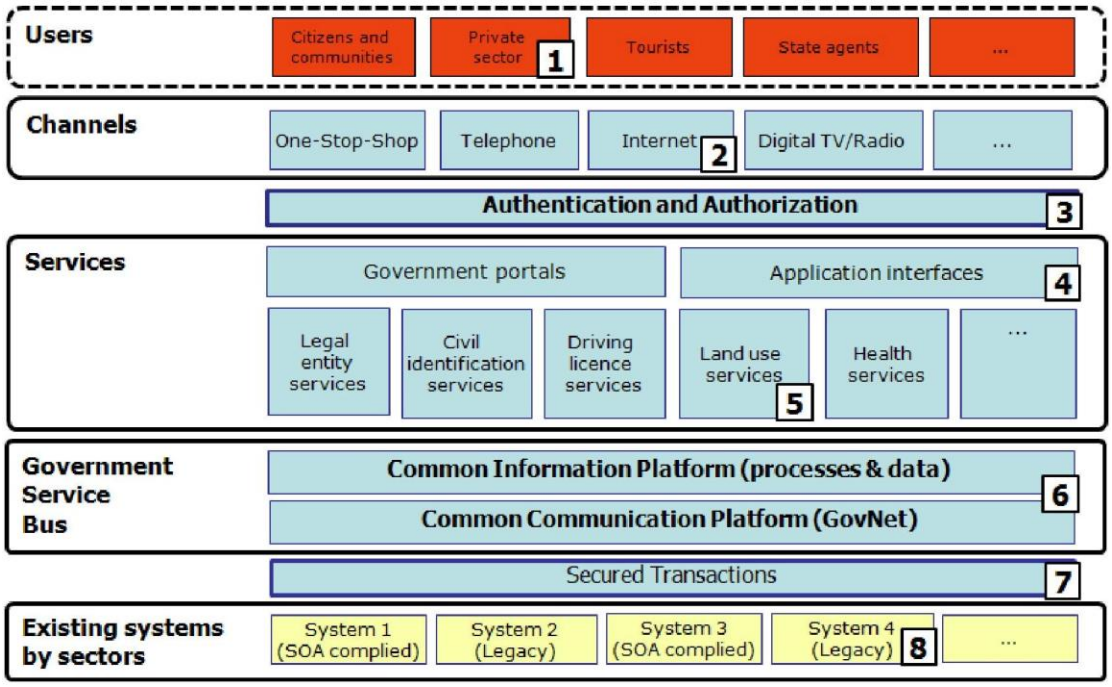


Fig 7: eGIF4M Service Delivery Architecture.

Users who are the real service recipients who can be people, private sector officials like SMEs, government agents, etc**.**

Channels providing facilities, such as one-stop shop, telephone, internet.

Services that eGovernment provides, such as services for legal entities and services for civil identification.

The heart of interoperability is the **government service bus**. It is made up of two primary parts, the common information platform (offering data, services and process interoperability) and the common communication platform (providing network and facilities).

Existing sector-specific systems constitute current information systems (which can be accomplished by SOA or heritage) by sector. Some examples include Enterprise Licensing and Cadastral Information System, State Financial Information System, eLand Registry and Land Management Information System.

Organizational structure

EGIF4 M involves a complicated collection of projects that require a well-defined cross-departmental organisation and clear and coordinated horizontal procedures. The objective of this set of activities is to identify and/or establish a government reference structure that will be responsible for guiding the interoperability initiative, both at the strategic and technical level.

This organization should be managed by the person in charge of the general oversight of EGIF4 M (i.e. the owner of this interdepartmental project), who is also in charge of the overall coordination of the project.

2.4.4 eGIF4M Interoperability Maturity Model (IMM)

One important aspect of eGIF4 M is the capacity to assess the amount of the interoperability structure being adopted and disseminated. Indeed, such capacity enables decision-makers and program managers to more accurately understand eGIF4 M's level of acceptance, effect, and achievement. It also enables the planning of actions aimed at improving service delivery through the implementation of the framework for interoperability.

A technique for determining the amount of maturity. For example, this can be achieved by assigning the maturity level shown by the assessment target to achieve each objective. It is possible to use a conversion feature, e.g. as a (weighted) results median.

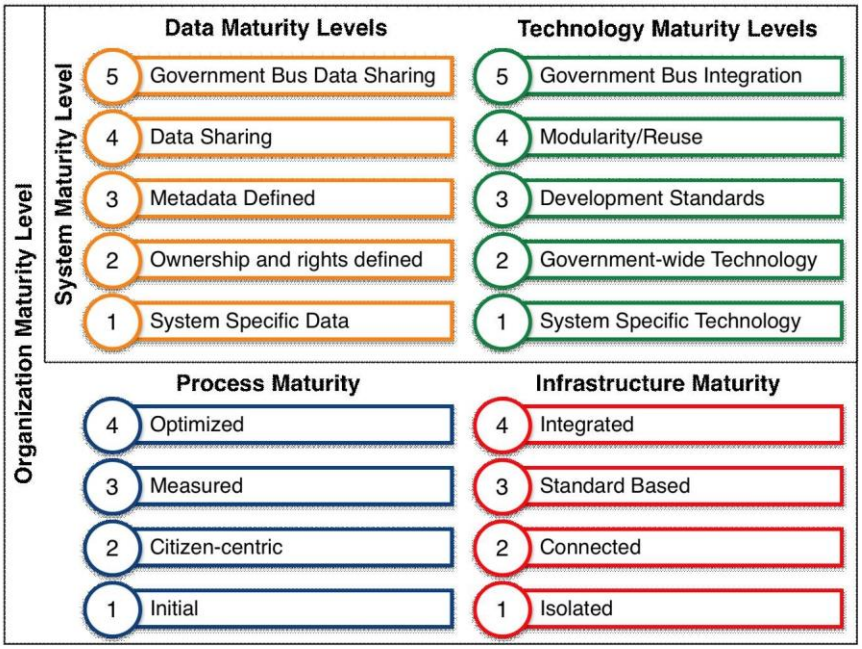


Fig 8: Interoperability Maturity Model

2.5 Interoperability Frameworks Summary

As per the literature review done, countries are still immature when it comes to interoperability innovations hence far from achieving profound service transformation. Disadvantages encountered when implementing IFs among countries include:

i. Over-designed: Too much detail that is not essential for the technical view. In the recent past, the industry has changed, so the solutions to many of what had previously been seen as technical barriers to interoperability cannot be considered important in today's globe.

ii. There is still a lack of focus on government-wide business transformation and, in essence, the interoperability agenda. It has helped to concentrate on Enterprise Architecture, but the work on this has been influenced by the particular requirements of the world's biggest government.

The models addressed, like the U.S. Federal Enterprise Architecture (FEA), which many others see as a model, are very focused on enhancing the effectiveness of each individual organization, and organizations need to create their own EA consistent with the FEA, much less on transforming citizens ' connection with the state as a whole. In Europe, the discussion on extending interoperability into the organisational and political layers is in principle correct, but in reality the

ongoing over-emphasis on the technical layer in the EIF is drowning out. Finally, several governments are struggling to move their IF from a paper-based to a distributed reality. Despite the problems raised about the interoperability agenda limitations, it also provides more that is highly useful. Typically, governments recognize that a printed structure can be difficult in practice to translate into continuous and transformative change.

In addition, the EIF dialog is enforced separately from the abundance of significant advancement that some governments are making in addressing structural obstacles to the conversion of national service.

2.6 The Proposed Conceptual Framework

The interoperability frameworks studied so far, had at least technical, semantic, organizational or interoperability factors mentioned.

The context within which inter-communication drivers were thought of was usually applied to regions, the key participating establishments, current existing infrastructure and their applicability. Since we tended to fall substantially under interoperability, the elements of those that impacted the execution of the National Population Register had to be considered.

According to Al-Khouri, (2012) ICT initiatives achievement indicators were the factors that spurred the successful implementation of ICT projects. They included vision and strategy, support from Government, outside pressure and support from donors, increase in consumer expectations, change in technology, modernization, and globalization. In addition, Al-Khouri, (2012) described inhibitors as impediments that did not necessarily pre-empt the implementation of ICT initiatives but they forestalled the advancement and restricted successful implementation and sustainability. They included user requirements, technology, coordination, ICT Policy and donor push. The drivers and inhibitors as defined in the literature, formed part of the conceptual framework as they were closely assembled to the implementation of the interoperability framework.

The proposed framework was premised on the Indian Interoperability framework. Technical, organizational and semantic interoperability were all considered.

2.6.1 Technical Interoperability

The conceptual structure did not depend on what had earlier been seen as technical obstacles to interoperability as projects were conceived into a broad range of competitive, business goods. (Eggers,2011) contends that Interoperability isn't just technical, it has many other angles to it. In real sense, the technology facet in most cases was the smallest to handle, whereas organizational, legal, political, and social ventures in most cases proved to be the challenge. The framework looked into issues where data security poignantly came out as an important component of technical interoperability due to the sensitivity of persons data involved. Focus was put to measure Open standards, real-time data flow, legacy systems, common infrastructure and Service oriented architecture .Data privacy, moreso was used to ensure there was authorized access to person's data, while open standards provided cross-integration amongst systems irrespective of the vendor, real-time data flow ensured that data moved with speed between the central register and the feeders of data, legacy systems has to be avoided at all costs to ensure compatibility, common infrastructure to ensure ease of data sharing and service oriented architecture to permit enterprise integration irrespective of technology deployed.

To support integration initiatives for the sake of the National Register, registers need to support:

i) Open standards-Integration should not be hampered by vendor specific systems. Proprietary systems should be prevented at all costs.
ii) Legacy systems -Integrating systems should be brought at par technologically so as to allow inter-data exchange devoid of incompatibility due to old unsupported systems.
iii) Common infrastructure-Infrastructure available at parties relevant to integration of person's data will ensure ease of data flow, ease of storage et cetera and hence support integration

According to the literacy assessment, the semantic element was deemed critical to ensuring that any individual or application receiving the data understands the exact significance of the information exchanged by the individual.To achieve this, an agreement was required on the context and precise meaning of the exchanged data. This was particularly important due to the various organisations that were concerned with collection and use of person's information that was necessary for harmonization of data heterogeneity.

2.6.2 Organizational Interoperability

Patrick H. et al, (2013) mentions that to enforce interoperability governance, sector specific registers need to adapt to interoperability by:

i. Introducing Legislation, policy and strategy to govern the whole interoperability structure of the National register.
ii. Availability of resources as these initiatives are capital intensive. This will ensure there smooth running and prevent stallment.
iii. Bureaucracy-Registration processes tend to be shrouded under bureaucratic governance hence difficult to implement. Once this is addressed, it becomes easy for these initiatives to sail through. to sail
iv. Business process re-engineering-For full compliance, archaic processes need to be re-invented and aligned accordingly so as to keep all services abreast and hence ensure interoperability
v. Political influence-Politics takes the centre stage in implementing this initiative. Getting the nod for political buy-in leads to ease of implementing these projects. (Gerald Sussman,1997) avers that technology and policy are mutually inseparable in the information age, the atmosphere in which technological enterprises are engaged is fundamentally political in nature
vi. Synergy-The relevant departments to the central population registration need to work in synergy so as to see positive achievement. In situations where positive energy in co-ordination has been realized the achievement targets tend to be higher

2.6.3 Semantic Interoperability

(Kalr D,2011) Specified that semantics is a globally acknowledged challenge that needs to be resolved in order to share population records among heterogeneous structures and to exploit population information in them to the fullest advantage of data stakeholders. Semantic interoperability needed the application of norms not only for the transfer and structural mapping of population information into the National Population Register, but also for the interpretation of the information material of the information feeders in accordance with the initial meanings. Accurate and comprehensive population data documentation, loyal to the information of the individual and interoperability between registration schemes, needed universal and safe access to

documented and preserved collections of logical and quality-assured semiconducting assets, including frameworks such as archetypes and templates that would (1) provide population data context, (2) map interop.

The interoperability of semantics has been influenced by:

i. Data integrity is the maintenance and assurance by the sourcing institutions of the precision and consistency of population information until the National Population Register is reached. In brief, its aim is to prevent unintended modifications in information about population data.

ii. Data Ownership- (Loshin, 2002)details that data ownership is, in particular, a data management initiative linked to the legal possession of population-wide data by a register. A particular register is capable of creating, editing, modifying, sharing and restricting access to information particular to its industry. Population information ownership also describes the authority of the information owner to delegate, share or grant to another party all of these privileges. If an inner or external party illegitimately violates their information ownership, the register which holds property rights to such population information may take legal action.

iii. Seamless Data Exchange- Implementing SOA with listening capacities in conjunction with common infrastructure will allow seamless information exchange within the population information ecosystem.

iv. Data Standards- Organizations of population registration exchange data according to a set of norms. Most of the norms are based on information format / structure, or codes or terms meanings. They decrease the cost of implementing and accelerate the integration of population initiatives and make it simpler to execute, exchange and integrate population information by ensuring that there is a clear understanding of how the population information is represented and that the information obtained are in the anticipated form.

2.7 Summary of the Interoperability Issues

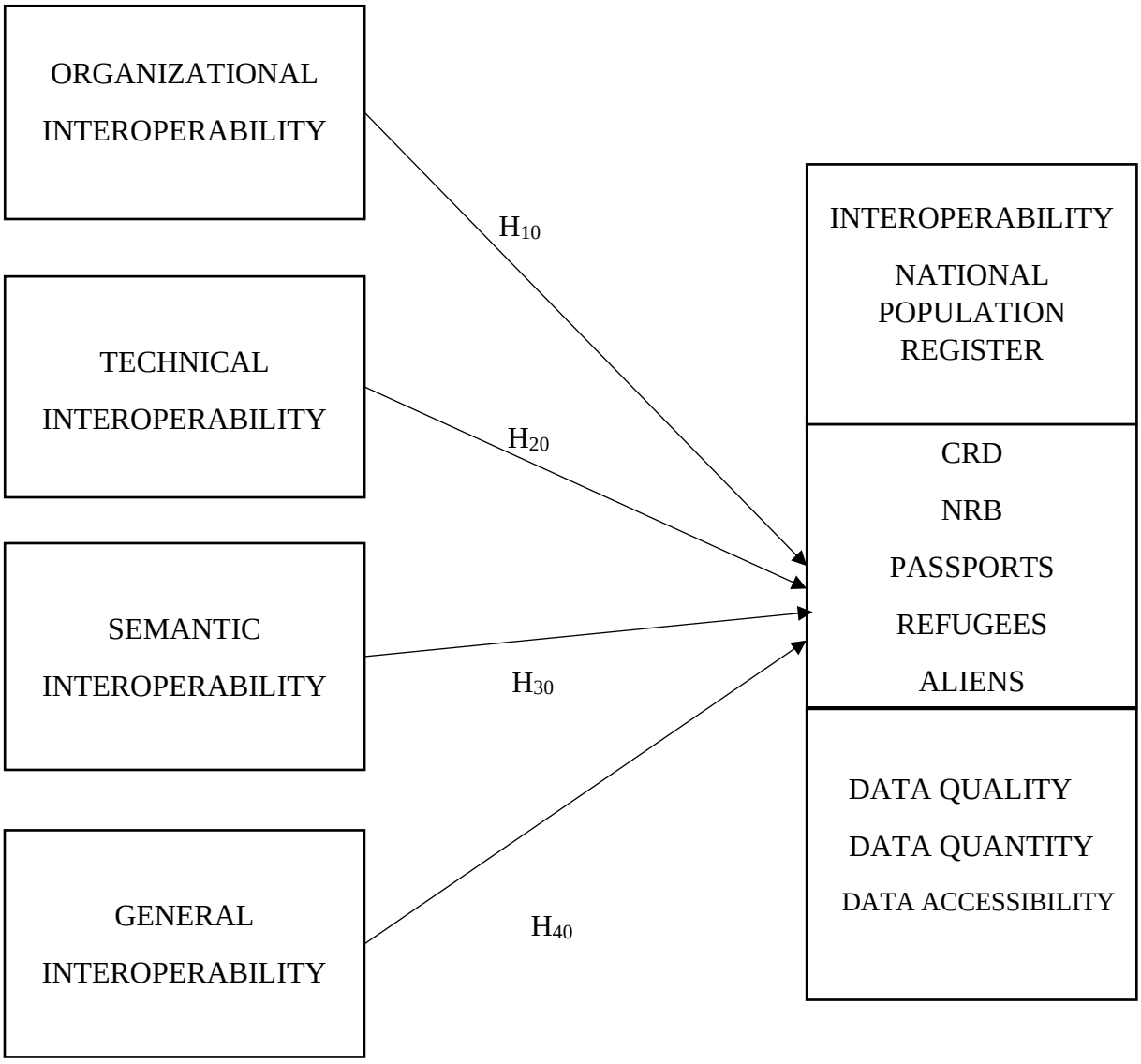
The following table outlined the interoperability issues that fell under each category of the conceptual framework as outlined above.

Table 1: Conceptual Framework Interoperability Issues

Interoperability Categories	Measurement of interoperability Parameter	The level of interoperability to be measured
Technical Interoperability	Data Security and Privacy	Measure of security impact on interoperability
	Open Standards	Measure of the impact of databases and proprietary biometric systems
	Real-time data flow	Measure of effect of immediate flow of data
	Legacy Systems	Measure of impact of the legacy systems
	Common infrastructure	Measure of impact of infrastructure for interconnecting systems
	Service Oriented Architecture	Measure of impact of interconnecting systems via services
Organisational Interoperability	Legislation, policy and strategy	Policy, strategy and legal affairs
	Resources	Economic Factors
	Bureaucracy	Measure of effects of bureaucracy to National Population Register
Interoperability Categories	Measurement of interoperability Parameter	The level of interoperability to be measured

	Business Process Re-engineering	Measure for the need for re-engineering the business processes
	Political Influence	Measure of effect of politics on National Population Register
	Synergy	Measure of collaborative working efforts amongst the registration agencies and NPR
Semantic Interoperability	Data Integrity	Measure of accurate and correct data
	Data ownership	Measure of data ownership effect on interoperability
	Seamless Data Exchange	Measure of data audit effect on data transfer from various data sources
	Data standards	Measure of the effects of standards on interoperability.
General Interoperability	Seamless flow of data	Measure effect of ease of flow of data from various data sources
	Interoperability	Measure of the impact of how disparate registration systems interact
	Reliance on IT	Measure of effect of IT on interoperability
	Consistency of Data	Measure of the impact of e consistency
	Duplication of Efforts	Measure of effect of duplicate roles of registration systems
	Unique Identity	Measure of the impact of unique identity on population registers

The following figure was the Conceptual Interoperability Framework upon which the research project was based on.



KEY

TECHNICAL INTEROPERABILITY	**ORGANIZATIONAL INTEROPERABILITY**	**SEMANTIC INTEROPERABILITY**	**GENERAL INTEROPERABILITY**
Security and privacy	Legislation, policy and strategy	Data Integrity	Seamless flow of data
Open standards	Resources	Data Ownership	Interoperability
Real-time data flow	Political Influence	Data Standards	Information Technology
Legacy Systems	BPR	Seamless data exchange	Consistency of Data
Common Infrastructure	Bureaucracy		Duplication of Efforts
Service Oriented Architecture	Synergy		Unique Identity

Fig 9: Conceptual Interoperability Framework for National Population Register

2.8 Hypothesis Testing

Data was collected on what was considered from the literature review as very pertinent in organizational, technical and semantic issues as affecting National Population Register interoperability. The issues that were considered under Organizational interoperability included: Legislation, policy and strategy, resources, bureaucracy and synergy. In Technical interoperability included: Security and data privacy, open standards, Real-time data flow, Legacy systems, common infrastructure and Service Oriented Architecture. In Semantic interoperability included: Data Integrity, data ownership, data standards and seamless data exchange whereas in General Interoperability Seamless flow of data, Interoperability, Information Technology, Consistency of Data, Duplication of efforts and Unique identity were considered.

A questionnaire form was sent out with all those questions. Statistical hypotheses were applied on the results as follows:

1. Organizational Interoperability between National Population Register and sources of data, will have a significant impact on National Population Register. (**H_{10}**)
2. Technical Interoperability between data sources and National Population Register will have a positive bearing on Central Master Register. (**H_{20}**)
3. Semantic interoperability within the people registration ecosystem will influence the direction of National Population Register. (**H_{30}**)
4. General Interoperability among the disparate registration agencies and the National Population Register will lead to an effective National Population Register. (**H_{40}**)

CHAPTER THREE METHODOLOGY

3.1 Research Design

The research was conducted in specific institutions that dealt directly with population registration functions in one aspect or the other. Goals were articulated concisely and with utmost care in the descriptive study to ensure that the data collected was relevant. This was to provide the desired information. A quantitative, descriptive study was conducted to determine:

i) Issues and challenges in establishing interoperability and information sharing among population registries into the National Population Register.
ii) Investigate the influence of Technical Interoperability, Organizational Interoperability and Semantic Interoperability with respect to data sources.
iii) To validate the framework using data accrued.

The research design used was a uni-variate and descriptive study design that was non-experimental. The study focused on ministries within the ecosystem of people registration.

In the research, the investigator acquired and analyzed the respondents ' opinions on the nature of their exposure to population registration information, the consumption of IPRS services in terms of internet identification, the advantages and opinions of their exposure, and the issues they encountered as they consumed IPRS services from day to day. The research was based on several variables that were grouped in categories. There was no manipulation of variables and minimal control of the research setting was exercised due to the nature of respondents targeted in the study. The conditions for information collection were standardized to improve data quality

3.2 Research Method

3.2.1 Target Population

The target population in this study were senior level managers and ICT technical officers who were concerned with activities closely related to the National Population Register in their respective statutory organizations. The senior managers had an influence in strategic decisions and an acceptable degree of knowledge in their activities related to NPR and consumers of National Population Register Data from IPRS department. They were determined by their cadres and geographical location as captured in the Government Human Resource repository.

The criteria for inclusion in the study were staff in the targeted organizations that were either officers in charge of jurisdictions for Identification Cards, Birth Certificates, Passports, Alien cards and Refugee cards, Immigration Officers, Birth Registrars,ID registrars, Refugee Officers or ICT staff concerned with registration systems and those manning systems whose activities are closely related to NPR.An acceptable academic qualification and specifically those having a degree and upwards. The staff with acceptable knowledge of the National Population Register systems, frequent users of the system and other related IT systems in the designated Organizations.

The first stage in sample design development was to identify obviously the set of objects, the universe to be studied. The eligibility criteria for inclusion in the study had the following attributes:

i) Personnel directly dealing with the registration of person's at the tactical and management level;
ii) An acceptable academic qualification and specifically those having a degree and upwards;
iii) The staff with acceptable knowledge of the person's registration systems, frequent users of the system and other related IT systems in the designated institutions;

3.2.2 Sampling frame and Sample Size

The details of the target population were obtained from the Government Human Resource Repository, contact persons in M.O.Us. signed with IPRS, LinkedIn, ZoomInfo, Google etc. The updated details received included names, job groups, designation, e-mail address and mobile contacts. The targeted officers from this population served as the sampling frame.

When the field survey was conducted, the choice of participants resulted in account of time and price. To produce a miniature cross-section, the respondents selected were as representative of the total population as possible (Ogula, 2012). Stratified sampling was used because the sample to be drawn was not a homogeneous group to acquire representative sample. The population was split into several sub-populations in the stratified sampling, which are separately more homogeneous than the complete strata population. (Kothari, 2004) As a result of their professions, academic training, orientation and exposure, the homogeneity of the respondents in the target population was classified as Strata as defined in stratified random sampling. The disjointed groups of the five targeted organizations, respectively, wereN1,N2..... N5 units. The subgroups, called strata, together formed the entire population, so that the target stratum was formed by N1 + N2...+ N5= N as shown below. The values of the targeted institutions that form the strata are as illustrated.

The following statistical formula was used to determine the sample size to obtain the required information with the least sampling error.

$$\text{Sample size} = \frac{\frac{z^2 \times p\,(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p\,(1-p)}{e^2 N}\right)}$$

N = population size • e = Margin of error (percentage in decimal form) • z = z-score

Where n was the sample size, N was the size of the population and e was the amount of accuracy (say 95% confidence level (±5% accuracy).

Table 2: Breakdown of Sample Strata Values

Institutions	**Strata size**	**Strata value**
Civil Registration Department	N1	
National Registration Bureau	N2	
Integrated Population Registration Department;	N3	
Department of Immigration	N4	
ICT officers from across the Ministries.	N5	
TOTAL		

The sample size was arrived at, after application of the formula above.

Table 3: Sample size of the Stratas

Institutions	**Strata size**	**Strata value Ni**	**Sample** $\text{Sample size} = \frac{\frac{z^2 x p (1-p)}{e^2}}{1 + \left(\frac{z^2 x p (1-p)}{e^2 N}\right)}$ N = population size · e = Margin of error (percentage in decimal form) · z = z-score
Civil Registration Department	N1		
National Registration Bureau	N2		
Integrated Population Registration Department;	N3		
Department of Immigration	N4		
ICT officers from across the Ministries.	N5		
TOTAL			

3.2.3 Data Collection Methods

A self-administered questionnaire was developed using online survey tools and the url of the site generated. This choice was necessary because was possible to reach as many of the targeted respondents as possible their geographical locations notwithstanding. This was to ensure the achievement of economic viability of the study in terms of financial and time constraints of distributing the questionnaires. The url of the site was circulated to the targeted respondents through their email addresses that had earlier been acquired from the Government human resource repository and signed M.O.Us. This was accompanied by phone calls to as many as possible of the participants in order to improve their response rate.

The respondents will fill the questionnaires and the responses from the url will be collated into the web server database.

Kothari (2004), referred to the need to ensure appropriate safeguards against bias and uncertainty while developing information collection procedures. Questions were well examined and rendered unambiguous, regardless of the technique chosen. Pre-testing was performed to determine the feasibility and validity of an tool (Brink & Wood, 1998). Validity of this situation, referring to the degree to which a device could assess its planned purpose (Polit & Beck,2004). Prior to

information collection, the investigator pre-tested the questionnaire to improve its validity and remove any ambiguity. This was achieved by subjecting the questionnaire to three domain area experts to get their inputs.

Before the actual data collection was carried out (Kothari, 2004), the processing and analysis procedure was planned in detail and earlier. The questionnaires language was kept as simple and non-technical as possible for the benefits of the non-technical respondents. The research also ensured the flow of the questions in a manner not likely to intimidate the respondents especially the non-technical staff.

3.3 Coding of the Data

The data was collected and captured google forms and then transposed to Microsoft excel worksheet and finally imported into SPSS package. Each question was assigned a number that made a distinction of which section of the questionnaire it came from. The questionnaire in this case had different sections covering different aspects that were investigated in relation to the research objectives. There were two main types of questions that were used for the survey. Likert-type questions that were assigned numbers 1 to 5 as per below, and were referred to as ordinal data.

Table 4: Likert type questions codes

Response	**Code**
Strongly agree	1
Agree	2
Neither Agree nor Disagree	3
Disagree	4
Strongly Disagree	5

The questions on respondents profile were coded as nominal data. The section that was used for measuring the levels of priorities in respect to the parameters under research were be considered also as ordinal. These types of questions were also coded in order of priority. The strings were converted into integers for quantitative analysis. The data that were randomly sampled from the

five strata was eventually combined into one file. Once this was done, the data was eventually coded awaiting analysis.

3.4 Validation and Reliability of the results

The validity of the resultant results was tested by having the conceptual framework discussed with other participants to see if there was existence of queerness (Lee,1991), so as to comprehend any subjective understandings. Cronbach's alpha statistical test was also used to determine the questionnaire's reliability.

CHAPTER FOUR RESULTS AND DISCUSSION

4.1 Introduction

The questionnaire was availed through google forms and sent to the targeted respondents who included ICT officers closely associated with National Population Register in the Ministries, senior technical administrators from National Registration Bureau, Civil Registration department, Department of Immigration and Integrated Population Registration Services department.

Filled questionnaires with responses were imported from the online google repository to an excel work sheet. Data cleansing of the responses followed thereafter to ascertain their correctness and completeness. The total number of questionnaires that had been filled was 94.

The questionnaire's primary objective was to validate the study goals. The questionnaire captured all metrics that were used to evaluate the National Population Registration interoperability framework.

4.2 Coding of the Data

The data was collected and captured in the Microsoft excel worksheet and then imported to SPSS package. The data from the google spreadsheet was not coded at this stage. Each question was assigned a number that made a distinction of which section of the questionnaire it came from. The questionnaire in this case had different sections covering different aspects that were investigated in relation to the research objectives. There were two main types of questions that were used for the survey. There was a set of Likert-type questions that were assigned numbers 1 to 5 as per below and were considered as ordinal data.

Table 5: Likert type questionnaire codes

Response	**Code**
Strongly agree	1
Agree	2
Neither Agree nor Disagree	3
Disagree	4
Strongly Disagree	5

The questions on participants profile was coded as nominal data. The section that was used for measuring the levels of priorities in respect to the parameters under research were also considered as ordinal data. These types of questions were also coded. The strings were converted into integers for quantitative analysis.

Table 6: Likert type questions codes

Response	**Code**
No Priority	1
Low Priority	2
Neutral	3
Priority	4
High Priority	5

The responses from the five stratas was finally combined into one excel sheet. Once this was done, the data was eventually coded awaiting analysis.

SPSS statistical software's (version 20) was used to perform statistical test and analysis. The findings, analysis and interpretations from the collected data of the targeted population were as below.

4.3 Reliability and Validity of the collected data

It was paramount to ensure that the data collected with the survey tools was reliable and valid. Cronbach's alpha test was used to measure how closely related a set of items were as a group. Two sets of items were measured. The first was the Likert-type of questions in the respective sections. The following table shows the results of this measure.

Table 7: Cronbach's alpha statistics output on reliability and validity of the data-Agreement Questions.

	Item-Total Statistics			
	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
Seamless flow of population data	33.00	79.075	.541	.846
Interoperability	32.85	77.655	.472	.844
Reliance on IT	32.96	79.439	.351	.848
Consistency of population data	32.86	77.368	.429	.845
Duplication of efforts	32.48	72.919	.615	.837
Unique Identity	32.82	75.462	.533	.841
Lack of legislation, policy and strategies	32.47	73.069	.630	.836
Lack of resources	32.43	73.925	.495	.841
Political influence	31.86	71.260	.456	.843
Business Process Re-engineering (BPR)	32.17	73.670	.460	.842
Bureaucracy	31.52	74.403	.222	.861
Lack of synergy	32.39	73.940	.661	.837
Data Integrity	32.87	76.414	.558	.842
Data Ownership	32.19	71.253	.386	.849
Data Standards	32.56	75.969	.459	.843

Accountability for data transfer	32.73	76.541	.592	.841
Security and privacy of data.	32.86	79.755	.121	.854
Open-standards	32.37	72.064	.458	.843
Real-time flow of data.	32.57	77.172	.274	.849
Legacy systems	31.99	73.796	.361	.848
Common Infrastructure	32.70	76.233	.489	.842

Table 8: Cronbach's alpha reliability statistics output-Agreement Questions

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
.850	.850	22

A reliability analysis was performed on a scale of 22 items for interoperability variables. Cronbach's alpha showed an acceptable reliability questionnaire, α= 0.850 (Taber,2013) These are the thumb rules for the Cronbach alpha reliability exam: 0.9 is outstanding, 0.8 is good, 0.7 is acceptable, 0.6 is dubious, 0.5 is poor and 0.5 is unacceptable. The three sets of issues had an alpha value of 0.850 for Cronbach coupled. This implies that all four sets of issues met the reliability limit.

Table 9: Cronbach's alpha statistics output on reliability and validity of the data-Priority Type Questions.

	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
Legislation, policy and strategies	53.78	364.240	.876	.953
Resources Allocation	53.47	377.520	.804	.955
Political support	54.24	377.821	.731	.956
Business Process Re-engineering	53.80	378.421	.720	.957
Bureaucracy	53.45	373.927	.766	.956
Synergy and harmony	53.62	372.669	.828	.955
Data correctness	53.67	360.869	.867	.954
Data Ownership	53.40	380.975	.674	.957
Meta Data standards	53.65	358.639	.930	.952
Seamless data exchange	53.53	360.166	.939	.952
Security and privacy	53.12	377.502	.714	.957

Open Standards	53.50	396.941	.462	.961
Real-time data exchange	52.84	382.480	.763	.956
Legacy Systems	53.19	403.769	.432	.961
Common Infrastructure	53.04	378.665	.776	.956
Service Oriented Architecture	52.86	385.153	.696	.957

The table below had results for Cronbach's alpha test for the questions testing validity and reliability of the priority type of questionnaires for each aspect of interoperability that was being investigated.

Table 10: Cronbach's alpha reliability statistics output-Priority Type Questions

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.959	.957	16

A reliability analysis was performed on a scale of 16 items for interoperability variables. Cronbach's alpha showed an appropriate reliability questionnaire, $\alpha = 0.959$ (Taber,2013) These are the thumb rules for the Cronbach alpha reliability exam: it is outstanding, 0.8 is great, 0.7 is appropriate, 0.6 is dubious, 0.5 is poor and less than 0.5 is unacceptable. The three sets of issues had an alpha value of 0.959 for Cronbach coupled. Again, this implies that all three sets of priority issues met the reliability limit.

4.4 Respondents of the Survey

This section detailed the results of the responses received from the survey.

4.4.1 Respondents by Strata's

The following table shows the percentage response from the four strata considered.

Table 11: Breakdown of the Respondents by Departments

Department	Sample Values	No of Responses	Percentage Turn-around
National Registration Bureau	28	20	100%
Civil Registration Department	26	26	100%
IPRS	8	8	100%
Department of Immigration	16	16	100%
Other Ministries	24	24	100%
TOTAL	**94**	**94**	**100%**

The hundred percent response rate from CRD, NRB, DOI, IPRS and other Ministries who were the technical arms in the National Population Register was made possible by persistent follow up calls to ensure that the number satisfied the sample targets.

4.4.2 Respondents by Gender

From the below table, 66% of the respondents were male whereas 34% were female. Given that the ratio of female to male employees is still low in the respective institutions, this was a clear indication that the survey was gender sensitive.

Table 12: Respondents by Gender

Gender	Frequency	Percent
Male	62	66.0
Female	32	34.0
Total	94	100.0

4.4.3 Respondents by Age

Table 4.7 below shows the participants by age. The selection of the ages was purely random. The results showed that 18.1% fell within 20-29 age bracket, 48.9% were within 30-39 age bracket, 26.6% were within 40-49 age bracket and 6.4% fell within 50-59 age blanket. Thus, most of the participants therefore were within 30-39 years. This age-group is characterized by its adoption of IT and this reinforces the validity of the survey results.

Table 13: Respondents by Age

Age blanket	Frequency	Percent	% of Total Sum
20-29	17	18.1%	17.7%
30-39	46	48.9%	51.6%
40-49	25	26.6%	21.0%
50-59	6	6.4%	9.7%
Total	94	100.0%	100.0%

4.4.4 Respondents by levels of education

The survey focused on management, ICT administrators and this explains the numbers of participants of Graduates and Post graduates both standing at 72.3 % and 27.3 % respectively. This is obviously a very knowledgeable portion of the society that undoubtedly reinforces the validity, precision and reliability of the survey results.

Table 14: Respondents by level of education

Level of Education	Frequency	Percent
O-Level	0	0
College	0	0
Graduate	68	72.3
Post-Graduate	26	27.3
Total	98	100.0

4.5 General Interoperability – Influence on National Population Register Interoperability

The questions in this section were used to assess the influence of general interoperability on National Population Register and its data sources. The results are herein analysed as below.

A massive 99% of all the respondents strongly agreed and agreed that there ought to be seamless flow of data into the National Population Register from the different data sources. This huge figure was attributed to registration workers encountering issues of lack of documents in NPR, as most of their work depended on availability of the records. Similarly, a total of 97.9%, of all the respondents strongly agreed/agreed that reliance on IT would have a significant positive influence on interoperability between NPR and data sources. Again, 52.1 % and 42.6% strongly agreed, agreed respectively, these were of the opinion that there was duplication of efforts among the registration agencies in terms of collection of population data, that is, different registration agencies collected the same data sets. The almost half split was because, registration personnel feel that, agreeing to duplicity meant ceasing their work functions in their respective work areas, to the National Population Register. Departments tend to be protective of their work jurisdictions.

95.8% of the respondents strongly agreed/agreed for the need of unique identifier so as to have the different registration documents identified with one unique number, that is IDs, Birtcertificates etc. It was to be noted that a paltry 2.2% were strongly against this idea.

A chunk of the respondents, 95.8 % strongly agreed/agreed that consistency/accuracy of data in NPR would significantly improve once interoperability with data sources was achieved.

Consistency of data in the National Population Register, posted a 96.8% strongly agreed/agreed from the respondents. This was manifested because of the characteristic inconsistent data between National Population Register and its data sources. Registrars and ICT officers ordinarily face numerous cases of data correction complaints at the National Population Register. This explained the strong posting.

From the above statistics, the level of average agreement was at an all-time high of 94.2%. An insignificant 2.2% average were in disagreement. This showed that it was important to note that there was clearly a need for National Population Register interoperability, with the factors named above, having a significant impact on interoperability. The results epitomised that seamless flow of data, reliance on IT, Consistency of data, Uniquely identifying individuals and Interoperability of registration systems had a significant influence on interoperability of National Population Register.

Table 15: Responses on general interoperability of National Population Register

		Strongly Agree	**Agree**	**Neither Agree/ Disagree**	**Disagree**	**Strongly Disagree**	**Total**
Seamless Flow of Data	Count	89	4	1	5	0	94
	%	94.7%	4.3%	1.1%	0.0%	0.0%	100%
Interoperability between data sources and NPR	Count	77	14	3	0	0	94
	%	81.9%	14.9%	3.2%	0.0%	0.0%	100%
Reliance on IT	Count	86	6	2	0	0	94
	%	91.5%	6.4%	2.1%	0.0%	0.0%	100%
There is duplication of efforts	Count	49	40	0	4	1	94
	%	52.1%	42.6%	0.0%	4.3%	1.1%	100%
Uniquely identifying individuals	Count	78	12	2	1	1	94
	%	83%	12.8%	2.1%	1.1%	1.1%	100%
Consistency of population data in National Population Register	Count	80	11	1	2	1	94
	%	85.1%	11.7%	1.1%	2.1%	0.0%	100%

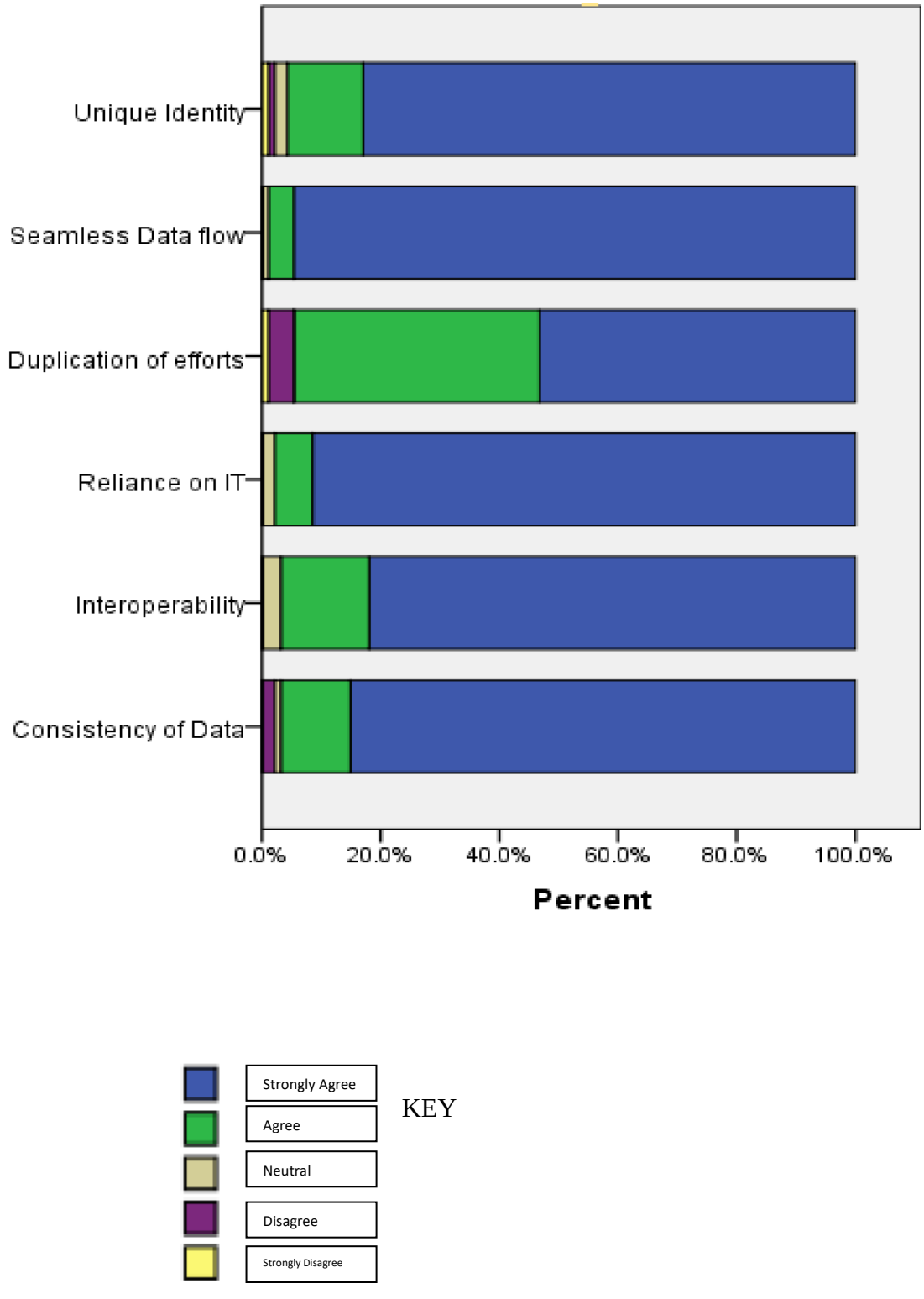


Fig 10: Stacked bar graph responses on general interoperability of National Population Register

4.6 Organizational Interoperability Influence on National Population Register

Earlier discussions in literature review on factors affecting National Population Register, had organizational interoperability as a component of issues that influenced the proper implementation of the register. Questionnaire interrogation featured these factors, herein discussed.

52.1% and 38.3% of the respondents strongly agreed/agreed that lack of legislation, policy and strategies was a challenge to National Population Register interoperability. A paltry 2.2% disagreed. 57.4% and 23.4% respectively were of the opinion that lack of resources attributed to poor budget process had an impact on the overall interoperability of registration agencies,18.1 % chose to remain neutral on the subject matter and this was a significant proportion that showed that lack of resources due to budget constraints wasn't a critical determinant of interoperability. In regards to political influence, A paltry 54.2% strongly agreed/agreed that political influence had an impact on National Population Register, in contrast 33% neither agreed nor disagreed,8.5% disagreed and 4.3% strongly disagreed. This showed that political influence was not a strong factor in interoperability of National Population Register. Also, of interest was the significant percentage on neutrality (33%) on political issues and 12.8% disagreeing. This showed that civil servants tended to avoid politics because of the Government clause, that Civil servants shouldn't engage in politics. BPR had 42.6% and 30.9% strongly agreed/agreed respectively effect on the subject matter and 22.3% maintained neutrality.4.3% were not of the affirmative on the question. On bureaucracy,26.6% and 35.5% respectively strongly agreed/disagreed,11.7% were of neutral opinion whereas a significant 26.6% disagreed on bureaucracy, hence watering down its effect on interoperability as compared to other factors. Lack of synergy had a 40.4% and 54.3% respectively strongly agreed/agreed, a neutrality of 4.3% and a paltry 1.1% disagreement. This showed that a significant percentage of stakeholders want harmonious working among the different stakeholders so as to improve interoperability of National Population register, thus departments need to work in harmony and synergy, if ideal status of the National Population Register was to be met.

Table 16: Responses of Organizational Interoperability issues

		Strongly Agree	**Agree**	**Neither Agree nor Disagree**	**Disagree**	**Strongly Disagree**	**Total**
Lack of legislation, policy and strategies	Count	49	36	7	1	1	94
	%	52.1%	38.3%	7.4%	1.1%	1.1%	100%
Lack of resources	Count	54	22	17	0	1	94
	%	57.4%	23.4%	18.1%	0.0%	1.1%	100%
Political Influence	Count	38	13	31	8	4	94
	%	40.4%	13.8%	33.0%	8.5%	4.3%	100%
Business Process Re-engineering	Count	40	29	21	3	1	94
	%	42.6%	30.9%	22.3%	3.2%	1.1%	100%
Bureaucracy	Count	25	33	11	9	16	94
	%	26.6%	35.1%	11.7%	9.6%	17%	100%
Lack of synergy	Count	38	51	4	0.0%	1	94
	%	40.4%	54.3%	4.3%	0.0%	1.1%	100%

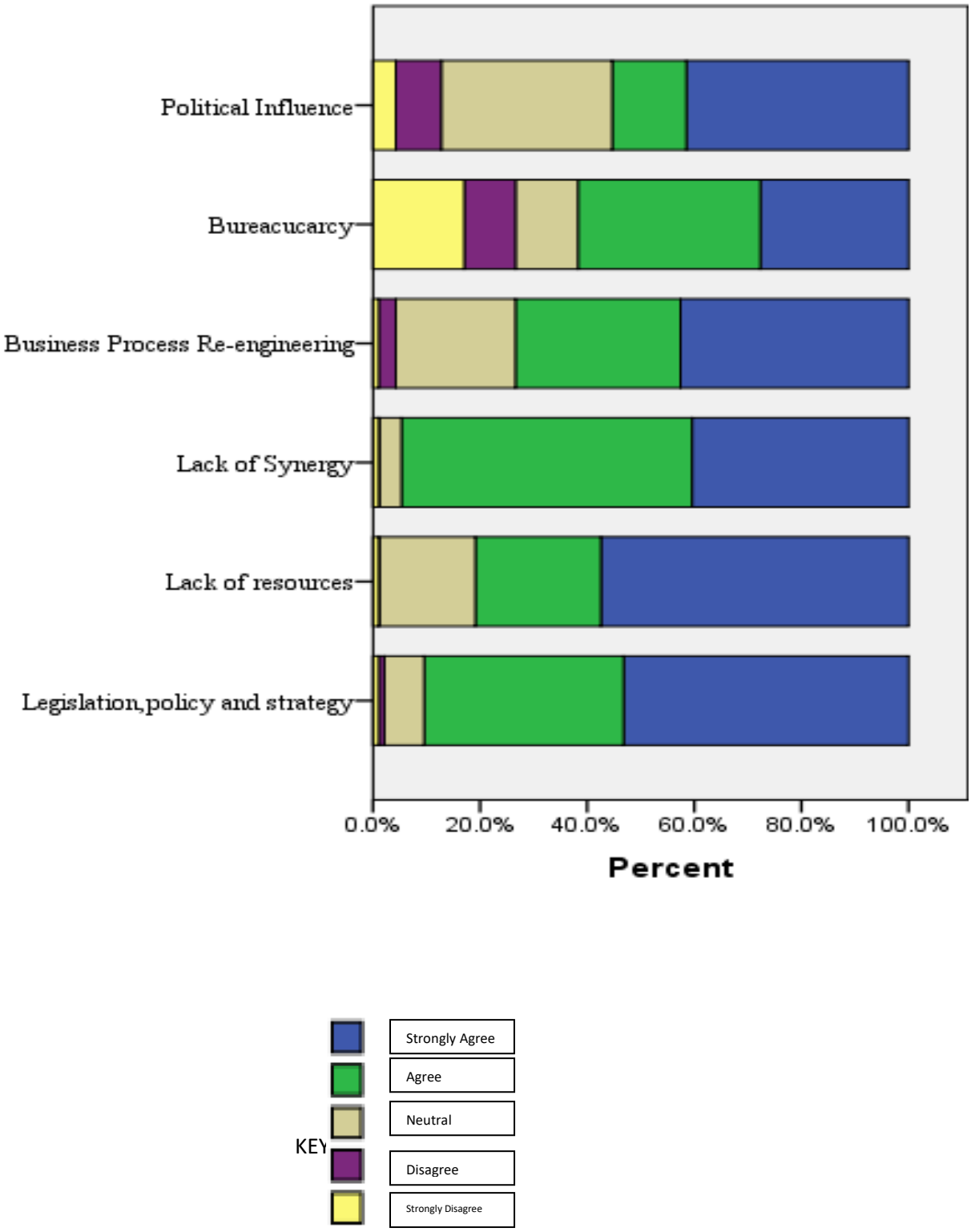


Fig 11: Stacked bar chary responses of Organizational Interoperability issues

The responses received in the interoperability part of the questionnaire buttressed the need for resources, policy, strategy, legislation and synergy among others for interoperability of National Population Register to be effective. Neutrality had a significant chunk on political influence.

In every thematic area of interoperability surveyed, there were areas that measured the priority rankings that the respondent would accord each aspect required for interoperability of National Population Register. To overcome the bias of means of ordinal data, Friedman test was considered as the most appropriate test that would provide mean rankings of factors considered in each area of interoperability considered.

Table 17 shows the Friedman's rank means for the six issues considered in the order of priority in the organisational interoperability. The respondents felt that good resources allocation was the greatest factor in implementing interoperability of National Population Register, whereas political support was the least factor affecting interoperability of National Population Register

Table 17: Level of Priorities for Organizational Interoperability Factors

	Interoperability Factors	**Mean Rank**
1	Resource Allocation	4.15
2	Elimination of bureaucracy	3.65
3	Business Process Re-engineering	3.57
4	Operations in synergy and harmony	3.46
5	Implementation of legislation, policy and strategies on central database	3.39
6	Political support	2.78

Table 18: Fried man test Statistics-Organization Factors

N	**94**
Chi-Square	44.806
df	5
Asymp. Sig.	.004

By further analysis of Friedman test with a confidence interval of 0.05, and the null hypothesis Ho: there is no difference between the six conditions and the alternate hypothesis

H1: there is a difference between the six conditions

Resulted in the Chi-Square value of 44.806 which is greater than 11.070 hence the conclusion that there is difference among the six groups as a result of test statistic 44.806 (5, n=94), $p<0.05$, hence the conclusion that there is difference among the six groups.

4.7 Semantic Interoperability Influence on National Population Register

The semantic interoperability factors were investigated and the findings were as below:

Data integrity from data sources had a massive 84% and 14.9% strongly agreed/agreed concurrence. A paltry 1.1% strongly disagreed. This showed the importance of data integrity from the data sources. Data ownership by the Government had 61.7% and 16.0% respectively, strongly agreed/agreed. This showed resistance to data ownership by vendors through proprietary rights. Standardization of data had a 60.6% and 28.7% respectively strongly agreed/disagreed. Data would be populated from different agencies and this data was read-only, hence the need to ensure correctness of data from the different agencies. Audit of data into the National Population Register would ensure that agencies populate the National Register from their end, this factor, attracted a 68.1% and 30.9% strongly agreed/agreed response and a paltry 1.1% neutrality, emphasizing its importance in the overall NPR interoperability.

Table 19: Responses on Semantic interoperability of National Population Register

		Strongly Agree	**Agree**	**Neither Agree/ Disagree**	**Disagree**	**Strongly Disagree**	**Total**
Data Integrity	Count	79	14	0	0	1	94
	%	84%	14.9%	0.0%	0.0%	1.1%	100%
Government data ownership	Count	58	15	5	7	9	94
	%	61.7%	16.0%	5.3%	7.4%	9.6%	100%
Metadata Standards	Count	57	27	10	0	0	94
	%	60.6%	28.7%	10.6%	0.0%	0.0%	100%
Data Exchange Audit	Count	64	29	1	0	0	94
	%	68.1%	30.9%	1.1%	0.0%	0.0%	100%

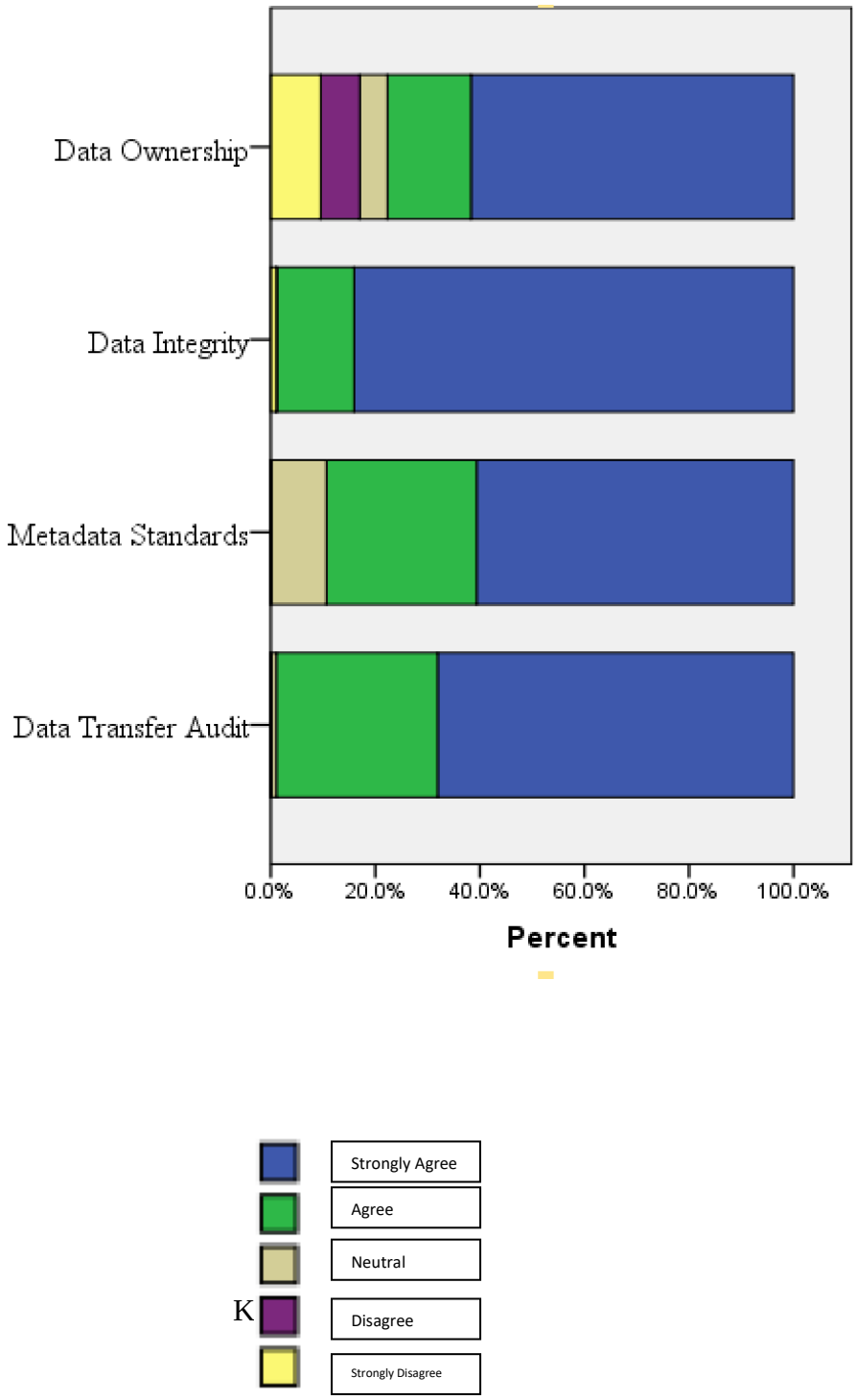


Fig 12: Stackbar diagram Responses on Semantic interoperability of National Population Register

Table 20 shows the Friedman's rank means for the four issues considered in the order of priority in the semantic interoperability. The respondents felt that data ownership was the greatest factor in implementing interoperability of National Population Register, whereas data integrity was the least factor affecting interoperability of National Population Register

Table 20: Level of Priorities for Semantic Interoperability Factors

Interoperability Factor	**Mean Rank**
Data Ownership	2.76
Seamless Data Exchange	2.51
MetaData Standards	2.41
Data Integrity	2.32

Table 21: Test Statistics Friedman Test-Priority Levels

N	**94**
Chi-Square	17.658
df	3
Asymp. Sig.	.001

More analysis by use of Friedman test with a confidence interval of 0.05, and the null hypothesis Ho: there is no difference between the four conditions and the alternate hypothesis

H1: there is difference between the four conditions results in the test statistic 17.658 (3, n=94), $p<0.05$, The Chi-square value of 17.658 was more than 7.81473, hence the conclusion that there was a difference among the four groups results.

4.8 Technical Interoperability Influence on National Population Register

The technical interoperability factors were investigated and the findings were as below:

Data security and privacy had a significant 89.4 % and 7.4% strongly agreed/agreed concurrence. A paltry 3.2 % strongly disagreed. This showed that citizens placed a significant importance to data security and privacy in the National Population Register. Use of Open standards in

implementing National Population Register had 61.7% and 22.3% respectively, strongly agreed/agreed. This showed resistance to implementing systems by vendors and expensive software licensing through proprietary rights. Real-time data flow had a 67% and 23.4% respectively strongly agreed/disagreed, emphasizing the need for on-demand accessibility of data. Legacy systems attracted a 43.6% and 18.1% strongly agreed/agreed response, a significant neutrality of 26.6% and a 10.6% disagreement. This showed, it was not a strong contender affecting interoperability. Common infrastructure had a 71.3% and 21.3% strongly agreed/agreed response and 0.0% emphasizing the need for this factor to realize interoperability of the National Population Register. Implementation of services as service had a significant 73.4% and 18.1% respectively, stressing the need for systems interoperability as services.

Table 22: Responses on Technical interoperability of National Population Register

		Strongly Agree	**Agree**	**Neither Agree/ Disagree**	**Disagree**	**Strongly Disagree**	**Total**
Data Security and Privacy	Count	84	7	0	0	3	94
	%	89.4%	7.4%	0.0%	0.0%	3.2%	100%
Open Standards	Count	58	21	5	6	4	94
	%	61.7%	22.3 %	5.3%	6.4%	4.3%	100%
Real-time flow	Count	63	22	3	6	0	94
	%	67%	23.4 %	3.2%	6.4%	0.0%	100%
Legacy Systems	Count	41	17	25	10	1	94
	%	43.6%	18.1 %	26.6%	10.6%	1.1%	100%
Common Infrastructure	Count	67	20	7	0	0	94
	%	71.3%	21.3 %	7.4%	0.0%	0.0%	100%
Service Oriented Infrastructure	Count	69	17	5	2	1	94
	%	73.4%	18.1 %	5.3%	2.1%	1.1%	100%

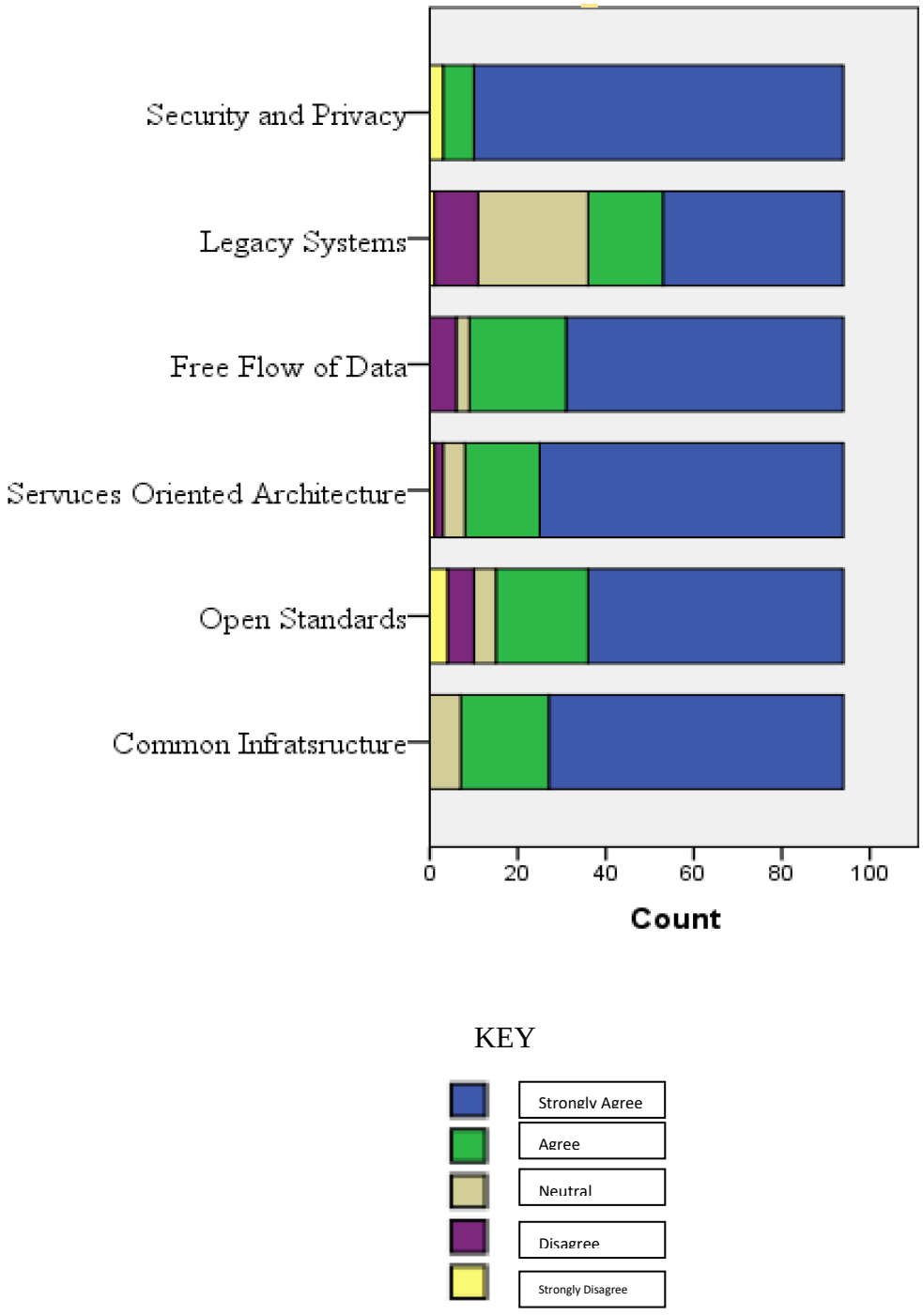


Fig 13: Stackbar responses on Technical interoperability of National Population Register

Table 23 shows the Friedman's rank means for the six issues considered in the order of priority in the technical interoperability. The respondents felt that real-time data exchange from data sources was the greatest factor in implementing interoperability of National Population Register, whereas open standards was the least factor affecting interoperability of National Population Register

Table 23: Level of Priorities for Technical Interoperability Factors

Interoperability Factor	**Mean Rank**
Real-time data exchange	3.78
Service Oriented Architecture	3.73
Security and privacy	3.60
Common and secure infrastructure	3.54
Legacy Systems	3.24
Open Standards	3.11

Table 24:Test Statistics Friedman Test-Technical Factors

N	**94**
Chi-Square	19.469
df	5
Asymp. Sig.	.002

By further analysis of Friedman test with a confidence interval of 0.05, and the null hypothesis Ho: there is no difference between the six conditions and the alternate hypothesis

H1: there is a difference between the six conditions results in the Chi-Square value of 19.469 which was greater than 11.070 hence the conclusion that there was a difference among the six groups as a result of test statistic 19.469 (5, n=94), $p<0.05$.

4.9 Hypotheses Testing

Values of -1.96 and +1.96 were taken as critical values where any z-values in between these two values would lead to acceptance of the hypotheses indicating that the respondents agreed or strongly agreed to the statements used in testing that hypothesis. Any values that were outside these values would lead to rejection of the null hypothesis and hence accept the alternate hypothesis

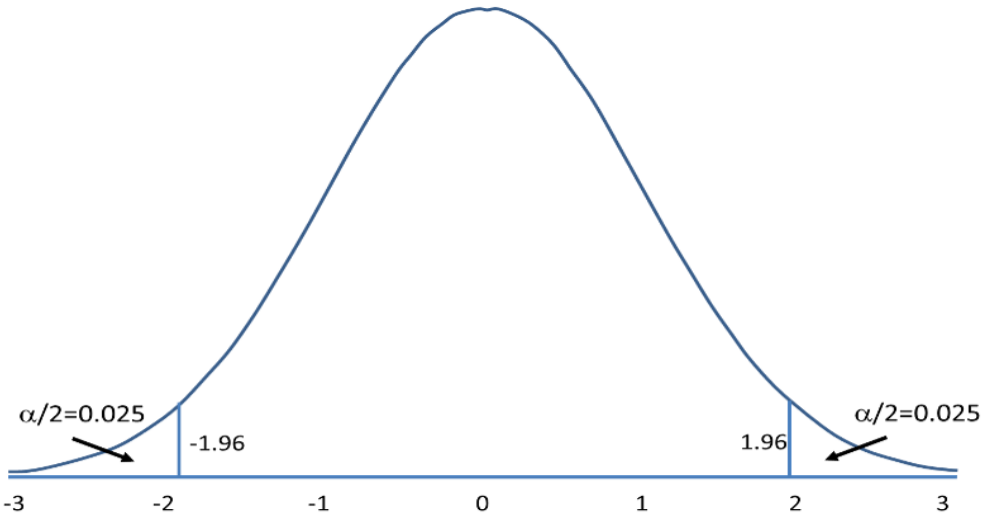


Fig 14: Rejection Region for Two-Tailed Test

Table 25: Z-Scores

Alternate Hypotheses	**Z**	**Sample Size (N)**	**Confidence Level (95%) α=0.05**
			Critical Values
H_{10}	2.267262	94	-1.96, +1.96
H_{20}	2.205106	94	-1.96, +1.96
H_{30}	2.16434	94	-1.96, +1.96
H_{40}	2.045712	94	-1.96, +1.96

H_{10} implied that Organizational Interoperability between National Population Register and sources of data, would have a significant impact on National Population Register. Its z-score was 2.267262, which was greater than 1.96, hence the null hypothesis was rejected and the alternate hypothesis accepted. The implication of this was that lack of legislation, policy and strategies on Central Master Register, affect implementation of National Population Register. Legislation, policy and strategies are central to the implementation of a national register. All the processes associated with national register must be anchored in law and have the support of top management. It should also be noted that, resources in form of budgetary allocation is critical to the implementation of National Registers as they are massive investments that require a lot of resources to implement, hence support in terms of economic factors is extremely critical to their survival.

Political influence affects implementation of National Population Registers. Election registers rely on population registers for data. This makes, politics a critical influence as to their existence, hence political support possessed the greatest challenge as to their sustenance. Another factor was that,Business Process Re-engineering (BPR) in registration agencies was necessary for effectiveness of a National Population Register. Most registration IT processes continue to rely on obsolete technologies that need overhaul to be in tandem with best practices moreso to be compatible with National Population Register processes. Bureaucracy impeded proper implementation of a National Population Register. Population registries are highly dependent on

other registers and bureaucracy being a characteristic of the isolated registries, then their proper functioning would greatly be impeded.

Lack of synergy between Data sources and National population register negatively affects interoperability. Collaborative efforts between registries is the panacea to an ideal status of the National Population Register. Further, data correctness and integrity should be implemented by data sources. National registers are hinged on data in, data out hence, a clean feed in mechanism from registries will ensure a good quality data set into the population register.

H_{20} petitioned that Technical Interoperability between data sources and National Population Register would have a positive bearing on Central Master Register. Its z-score was 2.205106, which was greater than 1.96, hence the null hypothesis was rejected and the alternate hypothesis accepted. Security and privacy of data was a concern in National Population Register. Security and privacy of data is the biggest concern in scenarios where large data sets of population data are conglomerated. Citizens have always been wary of how the data will be used, protected e.t.c and threats of gaining access into the system have always been a worry of custodians of such vital information.

Vendor-lock in Population databases is a nightmare as most of the registration systems are controlled by contractors. Open standards are better than proprietary systems that tend to lock clients to their vendors and software and are devoid of expensive software licencing.Such open channels should be pursued to make management of population registers better.

Inconsistency and unavailability of data in National Population Register was attributed to lack of real-time flow of data into the register. Real-time data flow into the central registry was a critical success factor for meeting the ideal status of the National Population Register. Success of these registries was heavily dependent on timely availability of data into the register.

Legacy systems negatively affect interoperability. Legacy systems tend to bring down up-to-date systems and must be replaced by all means to enable free flow of data into National Registries.

Common infrastructure improves effectiveness of seamless flow of data. In presence of this infrastructure, connectivity between the register and feed-ins databases is easier and results to faster transfer of data.

For ease of intra and inter change of data amongst registration systems, Services Oriented Architecture implementation is necessary. The advantages of SOA architecture can't be gain said. With this functionality, different registries with different methodologies of implementation, new Vs legacy systems and architecture allow inter-communication and hence immensely benefit the national register.

H_{30} opined that Semantic interoperability within the people registration ecosystem would influence the direction of National Population Register. Its z-score was 2.16434, which was greater than 1.96, hence the null hypothesis was rejected and the alternate hypothesis accepted. Correctness and integrity should be implemented by data sources. National registers are hinged on data in, data out hence, a clean feed in mechanism from registries would ensure a good quality data set into the population register.

Data ownership should be, by the Government. It is critical that data ownership be by the Government to avoid data lock ins by the vendors and give government freeway to operate its datasets hence allow free flow into the National Register

Semantic compatibility across the population registration ecosystem will be ensued by Population Meta Data Standards. Different registration agencies have different data formats of storing data, different sequences etc. A compatibility framework across the different registration agencies will enable easy merging of incompatible datasets in the National Register.

Effectiveness of a National Population Register will be dependent on accountability for seamless exchange of data between data sources and Central Master Register. Registries must be accountable to the data they supply to the National Population Register. Accountability brings discipline of data flow data into the register.

H_{40} stated that General Interoperability among the disparate registration agencies and the National Population Register will lead to an effective National Population Register. Its z-score was 2.045712, which was greater than 1.96, hence the null hypothesis was rejected and the alternate hypothesis accepted. Seamless flow of population data from data sources (registration agencies) into the National Population will lead to an effective National Population Register. Hence, National Population Register is dependent on seamless flow of data from respective sources into the register.

Interoperability between data sources and the National Population Register will have a positive bearing on Central Master Register. The result of this is that, the importance of the general interoperability between data sources and the register can't be overemphasized. It is necessary for the ideal status of the register to be realized. The disparate registries must operate in synergy with the National Register to realize full potential of interoperability.

Reliance on IT will have a significant positive effect on National Population Register. The importance of Information Technology in implementation of National Population Register can't be ignored. The processes between National Register and registration agencies are completely reliant and dependent on Information Technology. Adopting Information technology in registration processes has an increase in output in interoperability.

Interoperability between National Population Register and sources of data, will improve consistency of population data in National Population Register. Central registries can be characterized by inconsistencies of data, however when interoperability is achieved, then consistency is greatly improved.

Duplication of efforts exists among the different data sources. The fundamental question of duplicity of roles among the various registration agencies is an impediment to resources and sharing of data. Various registration agencies duplicate roles hence wasting time and resources. Having this data in a central place will eliminate/reduce this issue hence enabling faster re-use of population data among the registration agencies.

A unique PIN is necessary so as to put the different registration documents into one identifiable unique number. The availability of a single unique number enables the use of an identity from birth to cradle as opposed to numerous identity documents. The single identity enables easy tracking of individuals and uniquely identifying individuals in the central register.

CHAPTER FIVE CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The research analyzed interoperability with respect to data sources in National Population Register. Technical, semantic, organizational and general interoperability factors were identified by examining literature review pertinent to the subject area.

An interoperability framework was derived from the gaps in literature review. This informed the interoperability framework for National Population Register. The results of data analysis validated the existing framework and confirmed that organizational, technical and semantic factors played a profound role as to the interoperability of the National Population Register with respect to data sources.

5.2 Conclusions

The study sought to contribute towards an interoperability framework for National Population Register that would steer efficient co-ordination, linkages of registration systems and information flows to oversee an ideal status of the National Population Register. By adopting a descriptive single case study, an understanding of the factors affecting the interoperability of the National Population Register with regards to information sources was accomplished. The research looked into constructs of the conceptual framework and established that technical, semantic and organizational factors were determinants to interoperability of the National Population Register with respect to data sources.

The challenges that were identified at interoperability level as to affect the National Population Register included: lack of seamless flow of population data from disparate population registers into NPR,inconsistency of population data between the National Register and the various sector specific registers, unavailability of unique identity to link all the registration documents, inadequate policy, legislation and strategies on central data management, scarcity of financial resources, political influence, lack of data standards framework,bucreaucracy,lack of synergy among the different registration agencies and data ownership wrangles.

Investigation of the interoperability factors, revealed that, inadequacies in real-time seamless flow of data from the disparate agencies into the National Population Register was the strongest, an

indication of the inconsistencies in people's data between data sources and the central registry. Data security and privacy was another factor that had a lot of significant consideration, a manifestation that stakeholders are extremely careful about how population data was handled in the central master database and measures towards security of it.An interesting observation was that, legacy systems scored the least, an indication that most of the registration systems have up to date systems and integrations issues lies elsewhere.Another,compeling statistic is that, duplication of efforts was among the lowest, buttressing the fact that silo mentality still dominates in these registration agencies.

To address interoperability challenges between the National Population Register and the disparate agencies, special emphasis must be put into policy, legislation and strategies on central population data management. This will act as the overall authoritative guide towards implementing the other factors. The validated interoperability framework should be part of the policies and strategies for effective management of centralizing the population data ecosystem.

As the country moves towards having a central identity management and as more and more entities in both public and private sectors migrate their services to electronic format, then the issue of having a central authoritative digital registry for real-time identity verification becomes a compelling factor. The multifaceted interoperability issues associated with the National Population Register and its feeders of data, has been buttressed as to their existence by data analysis. These issues are categorized into organizational, technical and semantic factors. Therefore, solution lies in addressing the issues raised by these factors.Thus,the validated interoperability framework will offer a guiding footprint in achieving a data governing framework towards persons data consolidation in the people registration eco-system.

5.3 Study achievements and contributions

The interoperability framework for National Population Register was formulated and validated through data analysis. The data analytical results endorsed the framework. Knowledge in the domain area of Population Registers was expanded. The study also identified factors that are likely to influence interoperability of National Population Register with respect to data sources. In identifying these interoperability drivers and barriers, the right decision can be made accordingly to reduce failures in integration of population data and encourage seamless integration and dataflows among the registration agencies. The people registration ecosystem currently lacks an

interoperability framework, formulation of this validated framework, will go a long way in addressing the inherent interoperability issues that have dogged the consolidation of persons data.

5.4 Recommendations for Practice

National registers cross-cut a multitude of both public and private sectors with their effect being profound more so in identity management, therefore they must be anchored in law through legislative policies to support their functions. The interoperability framework developed should be implemented as a policy that guides interactions of population registration departments and compliance to it, should be a must.

Integration of population data are ventures that require heavy financial investments. The Kenya's case is no exception. Budgets should be allocated to these initiatives so as not to strain their operations.

To achieve an ideal status of the register, significant attention should be directed towards automation of manual registration processeses, integration of registration systems through SOA and deployment of information technology in registration activities. Achievement of these, will lay the background for real-time seamless flow of population data amongst the registration agencies into the National Population Register.

Consistency of data in the register should be ensured. The same set of data in the primary registration agencies should be propagated to the national register. Inconsistencies should be avoided at all costs. Changes in data initiated at primary registration agencies should immediately be reflected in the National Register and this will uphold the data integrity of the National Register.

Consolidation of person's data into a single repository brings issues of data security and privacy. Fastracking of the data protection and privacy bill, should be a priority as it will provide a framework for protection of public data and citizen privacy. Mechanisms should be put in place to protect the data at all costs so as to assure citizens the safety of their data.

An educated community is an important aspect to the interoperability space. Departments that contribute directly to the National Register, should have a leadership that uphold the virtues of supporting interoperability. The same should flow to the cadres of technical staff that manage the systems and any other person that influences this data sharing framework.

There should be strong emphasis from governing bodies to routinely audit the implementation of the interoperability framework. This will guarantee a successful implementation of the register.

5.5 Further Research

The study was restricted to the main enrollment organizations due to time and budget limitations. Future research should expand to focus on the entire people registration ecosystem. Secondary and tertiary government agencies as well as private institutions that are possible feeders and consumers of data to/from the National Population Register should be targeted.

In literature review as well as data analysis results, the security of data has emerged as one of the contentious issues facing integration of person's data. Further research should be conducted in this domain area to identify the reasons and possible solutions.

REFERENCES

1. Odhir, (2012).'Guidelines on Population Registration'.
2. Poulain, (2012). 'Central Population Registers as a Source of Demographic Statistics'.
3. United Nations, (2014).'United Nation E-government survey'.
4. ID World Magazine, (2014). Retrieved from 9 August,2018,from http://documents.worldbank.org/curated/en/953621531854471275/Global-ID-Coverage-by-the-Numbers-Insights-from-the-ID4D-Findex-Survey.pdf.
5. Journal of Engineering Science and Technology, Vol. 3 No. 2, February 2011
6. MIRP, (2008).'Ministry of State and Registration of Persons Strategic Plan'.
7. ID4D, (2016)ID for Development. Retrieved 30October,2018 from http://documents.worldbank.org/curated/en/575001469771718036/text/Kenya-ID4D-Diagnostic-WebV42018.txt
8. Aby Jain, (2004). 'Using the lens of Max Weber's Theory of Bureaucracy to examine eGovernment Research'. Proceedings of the 37th Hawaii International Conference on System Sciences
9. Ali M. Al-Khouri, (2012). 'Data Ownership: Who Owns 'My Data ?', International Journal of Management & Information Technology, Volume 2, No 1
10. Apitep Saekow & Choompol Boonmee, (2009). 'Towards a Practical Approach for Electronic Government Interoperability Framework (e-GIF)'. Proceedings of the 42nd Hawaii International Conference on System Sciences.
11. Atallah, S., (2001). 'E-Government: Considerations for Arab States. United Nations Development Program, USA.
12. Baum, C. & DiMaio, A. (2000).'Gartner's Four Phases of E-Government Model'.
13. Bekkers, V., (2007). 'The governance of back-office integration'. Public Management Review, 9(3), 377−400.
14. Benoit O, Patrik H et al, (2007). 'Interoperability of E-Government Information Systems: Issues of Identification and Data Sharing'. Journal of Management Information Systems, Vol. 23, No. 4, pp. 29
15. C.R. Kothari, (2004) 'Research Methodology; Methods and Techniques'
16. Cabinet Office, (2005). 'E-Government interoperability framework'. E-Government Unit London, UK: Cabinet Office.

17. Chalapati Rao et al, (2009). ‘Compiling mortality statistics from civil registration systems in Viet Nam: the long road ahead’.
18. Chalapati Rao, Debbie Bradshaw and Colin D. Mathews, (2005). ‘Improving death Registration and statistics in developing countries: Lessons from sub-Saharan Africa’. Southern African Journal of Demography 9(2).
19. Mozambique,National e-government master plan,(2012). 'Mozambique,eGIF'.
20. Government Service Delivery: Achievements and Learnings from On-line Taxation in Greece”. Presented at the Workshop on e-Government in the context of the 8th Panhellenic Conference on Informatics, Nicosia, Cyprus.
21. Eggers W. (2004). ‘Boosting E-Government Adoption’.
22. Gerald Sussman (1997), Communication, technology and politics in the information age.
23. Giorgos L, Konstantinos M et al, (2007). ‘E-government and Interoperability Issues’.
24. IJCSNS International Journal of Computer Science and Network Security, VOL.7 No.9.

APPENDIX I

LETTER OF INTRODUCTION

Survey Questionnaire

University of Nairobi

School of Informatics and Computing

Interoperability Model Evaluation Questionnaire

My name is Moses Rading, a graduate student undertaking a Master's degree in Information Technology Management at the University of Nairobi. I am currently carrying out a study on Interoperability Model for National Population Register: A case study of IPRS. The focus of my research is to test the validity of a framework construct. Participation is voluntary and any information you provide will be kept confidential and used purely for academic research purposes. The questionnaire will take approximately 40 minutes. Your details or data collected or provided will not be passed to any third party. The filled online questionnaires will be destroyed after data collection and analysis.

Are you willing to participate in this interview? [1] Yes [0] No

Your response will be highly appreciated. Incase of any question or clarification, please contact me **moses.rading@gmail.com, moses.rading@kenya.go.ke or +254-721814326**

APPENDIX II

Questionnaire Section

Section A	**Personal Information**
Gender	1. Male 2. Female
Age Bracket	1. 20-29 2. 30-39 3. 40-49 4. 50-59
Level of Education	1. O-level 2. College 3. Graduate 4. Post- Graduate
Your Ministry/ Department	1. National Registration Bureau **2.** Civil Registration Department **3.** Integrated Persons Registration System Department **4.** Department of Immigration **5.** Other Ministries Specify…….
Section B	**GENERAL INTEROPERABILITY**

Please indicate your level of agreement to the statements below, about the level of interoperability between data sources and national population register (where 1- strongly agree, 2- Agree, 3- Neither agree/disagree, 4 – Disagree and 5 – Strongly Disagree)

1	There should be seamless flow of population data from data sources (registration agencies) into the National Population.	**1**	**2**	**3**	**4**	**5**

2	Interoperability between data sources and National Population Register will improve availability of data to National Population Register	**1**	**2**	**3**	**4**	**5**
3	Reliance on IT will have a significant positive effect on interoperability between Data sources and National Population Register.	**1**	**2**	**3**	**4**	**5**
4	Consistency of population data in National Population Register will be improved once interoperability is implemented between National Population Register and sources of data	**1**	**2**	**3**	**4**	**5**
5	There is duplication of efforts among the different data sources.	**1**	**2**	**3**	**4**	**5**
6	Uniquely identifying individuals in National Population Register with a unique PIN is necessary so as to put the different registration documents into one identifiable unique number.	**1**	**2**	**3**	**4**	**5**
Section C	**ORGANISATIONAL INTEROPERABILITY**					
Please indicate your level of agreement to the statements below, about the level of organizational interoperability between data sources and national population register (where 1- strongly agree, 2- Agree, 3- Neither agree/disagree, 4 – Disagree and 5 – Strongly Disagree)						
1	Lack of legislation, policy and strategies on central database (National Population Register) is a challenge affecting implementation of National Population Register.	**1**	**2**	**3**	**4**	**5**
2	Lack of resources due to poor budget provision has affected implementation of National Population Register.	**1**	**2**	**3**	**4**	**5**
3	Political influence has affected implementation of National Population Register.	**1**	**2**	**3**	**4**	**5**
4	Need for Business Process Re-engineering (BPR) in registration agencies (data sources)	**1**	**2**	**3**	**4**	**5**

	feeding data into the National Population Register.					
5	No need for special agreements, complicated procedures etc. in interconnectivity between Registration agencies and National Population Register(Bureaucracy)	**1**	**2**	**3**	**4**	**5**

6	Lack of synergy(operation in harmony) between Data sources and National population register negatively affects interoperability.	**1**	**2**	**3**	**4**	**5**
In a scale of 1 to 5 of priority which organisational issues needs to be addressed for interoperability to be implemented (where 1- Low Priority and 5 – High Priority)						
i	Implementation of legislation, policy and strategies on central database (National Population Register)	**1**	**2**	**3**	**4**	**5**
ii	Good resources allocation during budget making	**1**	**2**	**3**	**4**	**5**
iii	Political support	**1**	**2**	**3**	**4**	**5**
iv	Business Process Re-engineering	**1**	**2**	**3**	**4**	**5**
v	Elimination of bureaucracy	**1**	**2**	**3**	**4**	**5**
vi	Operations in synergy and harmony	**1**	**2**	**3**	**4**	**5**
Section D	**SEMANTIC INTEROPERABILITY**					
Please indicate your level of agreement to the statements below, about the level of semantics interoperability between data sources and national population register (where 1- strongly agree, 2- Agree, 3- Neither agree/disagree, 4 – Disagree and 5 – Strongly Disagree)						
1	It is the duty of registration agencies (data sources) to assure about data correctness and integrity.	**1**	**2**	**3**	**4**	**5**
2	It is the responsibility of Government to own population data.	**1**	**2**	**3**	**4**	**5**
3	Implementation of Population Meta Data Standards to bring semantic compatibility across population registration agencies.	**1**	**2**	**3**	**4**	**5**

4	Accountability for seamless exchange of data between data sources and National Population Register and monitored through audit processes.	**1**	**2**	**3**	**4**	**5**
On a scale of 1 to 5 of priority, what is your opinion on the level of challenge posed to interoperability of National Population Register by the following, (where 1-Low Challenge 5-High Challenge						
i	Accountability for correctness of data by data sources (registration agencies)	**1**	**2**	**3**	**4**	**5**
ii	Data ownership by the Government.	**1**	**2**	**3**	**4**	**5**
iii	Population data Meta Data Standards-e.g. Same date of birth formats, photo formats etc.	**1**	**2**	**3**	**4**	**5**
iv	Seamless Exchange of population data from data sources to National Population Register.	**1**	**2**	**3**	**4**	**5**
SECTION E	**TECHNICAL INTEROPERABILITY**					
Please indicate your level of agreement to the statements below, about the level of technical interoperability between data sources and national population register (where 1- strongly agree, 2- Agree, 3- Neither agree/disagree, 4 – Disagree and 5 – Strongly agree)						
1	Security and privacy of data is a concern in National Population Register.	**1**	**2**	**3**	**4**	**5**
2	Design and implementation of registration systems in open standard and formats to avoid vendor lock-in.	**1**	**2**	**3**	**4**	**5**
3	Lack of real-time flow of data from data sources affects availability and consistency of data in National Population Register.	**1**	**2**	**3**	**4**	**5**
4	Legacy systems negatively affect interoperability.	**1**	**2**	**3**	**4**	**5**
5	Central government establish common and secure ICT infrastructure for seamless flow of data e.g. data centres, Metro Networks (GCCN) etc.	**1**	**2**	**3**	**4**	**5**
6	Implementation of systems as services in form of SOA for easy of intra and inter change of data.	**1**	**2**	**3**	**4**	**5**
On a scale of 1 to 5 of priority, which technical factors need to be addressed for technical interoperability to be implemented (1- Low Priority ,5 – High Priority)						
i	Security and privacy	**1**	**2**	**3**	**4**	**5**

ii	Implementation of technologies on open standards devoid of vendor lock in	**1**	**2**	**3**	**4**	**5**
iii	Real-time data exchange from data sources to National Population Register	**1**	**2**	**3**	**4**	**5**
iv	Legacy Systems	**1**	**2**	**3**	**4**	**5**
v	Common and secure infrastructure	**1**	**2**	**3**	**4**	**5**
vi	Service Oriented Architecture Implementation	**1**	**2**	**3**	**4**	**5**
Section F	**OTHERS**					
	Name other major issues that you feel have an effect in the implementation of interoperability of National Population Register					