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SERIES Y: GLOBAL INFORMATION  
INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS,  
NEXT-GENERATION NETWORKS, INTERNET OF  
THINGS AND SMART CITIES

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**ITU-T Y.3500-series – Requirements and  
challenges regarding provision and  
consumption of cloud computing services in  
developing countries**

ITU-T Y-series Recommendations – Supplement 46

ITU-T



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## Supplement 46 to ITU-T Y-series Recommendations

### ITU-T Y.3500-series – Requirements and challenges regarding provision and consumption of cloud computing services in developing countries

#### Summary

Supplement 46 to the ITU-T Y-series Recommendations applies to the ITU-T Y.3500-series Recommendations. Cloud computing has the potential to alleviate some of the socio-economic challenges being faced in developing countries such as lack of resilient electrical power, lack of information and communication technology (ICT) infrastructure and can also improve service delivery to mention but a few.

Emanating from a survey conducted on the status of cloud computing in developing countries, this Supplement highlights the requirements and challenges of cloud computing provision and consumption in developing countries with regards but not limited to standards implementation, data connectivity and infrastructure deployment.

#### History

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## Introduction

The global trends in sectors such as health, agriculture, commerce, education, banking and finance have demonstrated that a significant amount of data will be delivered and accessed online. Most enterprises are looking for ways to improve operational efficiency and cut costs through least-cost operator strategies and outsourcing. Cloud computing is among the prominent technologies that are making this process viable. Governments are also beginning to leverage some of the characteristics of cloud computing such as on demand access and cost effectiveness to deliver improved citizen services and increase Government operational efficiencies.

In developing countries, cloud computing has the potential to:

- i) improve energy efficiency in every sector of the economy by consolidating IT services especially in government and banking sector;
- ii) improve service delivery and operational efficiency in various sectors such as health, tourism and transport;
- iii) create new business models;
- iv) build new skills in application and content development;
- v) promote environmental sustainability;
- vi) make significant savings in set up cost of IT solutions;
- vii) contribute significantly to the gross domestic product (GDP) and
- viii) create new job opportunities.

Despite the prospects outlined above, cloud computing adoption in developing countries is still low and several developing countries encounter many challenges to effectively contribute to the cloud economy. Various efforts are being made by numerous stakeholders to support accelerated implementation of cloud computing in developing countries and to build trust in the use of this emerging technology. However, there are many barriers affecting cloud computing adoption in these countries which need to be addressed before it can become a reality. These barriers vary significantly depending on the country's level of development and business and communications environments.

As a step towards creating an impetus to the deployment and usage of cloud computing services in developing countries, an ITU-T survey was commissioned to assess the current profile of cloud computing deployment and consumption in developing countries. The survey allowed for the identification of bottlenecks and weaknesses that need to be addressed to effectively exploit the cloud computing platform in developing countries. The findings of this survey are presented and analysed in this supplement.



## Supplement 46 to ITU-T Y-series Recommendations

### ITU-T Y.3500-series – Requirements and challenges regarding provision and consumption of cloud computing services in developing countries

#### 1 Scope

The scope of this Supplement to ITU-T Y.3500-series is to study and present the situation relating to the application of cloud computing services in developing countries, the obstacles encountered and the facets that would stimulate assimilation of cloud computing services based on experiences from these countries.

The Supplement also highlights the current requirements for provision and deployment of cloud computing services and to what extent cloud computing standards are applied in developing countries.

#### 2 References

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- [ITU-T Y.3502] Recommendation ITU-T Y.3502 (2014), *Information technology – Cloud computing – Reference architecture*.

[ITU-T Y.3503]	Recommendation ITU-T Y.3503 (2014), <i>Requirements for desktop as a service.</i>
[ITU-T Y.3510]	Recommendation ITU-T Y.3510 (2016), <i>Cloud computing infrastructure requirements.</i>
[ITU-T Y.3511]	Recommendation ITU-T Y.3511 (2014), <i>Framework of inter-cloud computing.</i>
[ITU-T Y.3514]	Recommendation ITU-T Y.3514 (2014), <i>Cloud computing – Trusted inter-cloud computing framework and requirements.</i>
[ITU-T Y.3520]	Recommendation ITU-T Y.3520 (2015), <i>Cloud computing framework for end to end resource management.</i>
[ISO/IEC 27002]	ISO/IEC 27002:2013, <i>Information technology – Security techniques – Code of practice for information security controls.</i>
[TIA-942]	TIA-942:2017, <i>Telecommunications Infrastructure Standard for Data Centers.</i>

### 3 Definitions

#### 3.1 Terms defined elsewhere

This Supplement uses the following terms defined elsewhere:

**3.1.1 cloud computing** [ITU-T Y.3500]: Paradigm for enabling network access to a scalable and elastic pool of shareable physical or virtual resources with self-service provisioning and administration on-demand.

NOTE – Examples of resources include servers, operating systems, networks, software, applications, and storage equipment.

**3.1.2 cloud service** [ITU-T Y.3500]: One or more capabilities offered via cloud computing invoked using a defined interface.

**3.1.3 cloud service category** [ITU-T Y.3500]: Group of cloud services that possess some common set of qualities.

**3.1.4 cloud service customer** [ITU-T Y.3500]: Party which is in a business relationship for the purpose of using cloud services.

NOTE – A business relationship does not necessarily imply financial agreements.

**3.1.5 cloud service partner** [ITU-T Y.3500]: Party which is engaged in support of, or auxiliary to, activities of either the cloud service provider or the cloud service customer, or both.

**3.1.6 cloud service provider** [ITU-T Y.3500]: Party which makes cloud services available.

**3.1.7 cloud service user** [ITU-T Y.3500]: Natural person, or entity acting on their behalf, associated with a cloud service customer that uses cloud services.

NOTE – Examples of such entities include devices and applications.

**3.1.8 communications as a Service (CaaS)** [ITU-T Y.3500]: Cloud service category in which the capability provided to the cloud service customer is real time interaction and collaboration.

NOTE – CaaS can provide both application capabilities type and platform capabilities type.

**3.1.9 community cloud** [ITU-T Y.3500]: Cloud deployment model where cloud services exclusively support and are shared by a specific collection of cloud service customers who have shared requirements and a relationship with one another, and where resources are controlled by at least one member of this collection.

**3.1.10 compute as a service (CompaaS)** [ITU-T Y.3500]: Cloud service category in which the capabilities provided to the cloud service customer are the provision and use of processing resources needed to deploy and run software.

NOTE – To run some software, capabilities other than processing resources may be needed.

**3.1.11 data storage as a service (DSaaS)** [ITU-T Y.3500]: Cloud service category in which the capability provided to the cloud service customer is the provision and use of data storage and related capabilities.

NOTE – DSaaS can provide any of the cloud capabilities types.

**3.1.12 desktop as a service (DaaS)** [ITU-T Y.3503]: A cloud service category in which the capabilities provided to the cloud service customer are the ability to build, configure, manage, store, execute and deliver users' desktop functions remotely.

**3.1.13 hybrid cloud** [ITU-T Y.3500]: Cloud deployment model using at least two different cloud deployment models.

**3.1.14 infrastructure as a service (IaaS)** [ITU-T Y.3500]: Cloud service category in which the cloud capabilities type provided to the cloud service customer is an infrastructure capabilities type.

NOTE – The cloud service customer does not manage or control the underlying physical and virtual resources, but does have control over operating systems, storage, and deployed applications that use the physical and virtual resources. The cloud service customer may also have limited ability to control certain networking components (e.g., host firewalls).

**3.1.15 infrastructure capabilities type** [ITU-T Y.3500]: Cloud capabilities type in which the cloud service customer can provision and use processing, storage or networking resources.

**3.1.16 network as a service (NaaS)** [ITU-T Y.3500]: Cloud service category in which the capability provided to the cloud service customer is transport connectivity and related network capabilities.

**3.1.17 party** [ITU-T Y.3500]: Natural person or legal person, whether or not incorporated, or a group of either.

**3.1.18 platform as a service (PaaS)** [ITU-T Y.3500]: Cloud service category in which the cloud capabilities type provided to the cloud service customer is a platform capabilities type.

**3.1.19 private cloud** [ITU-T Y.3500]: Cloud deployment model where cloud services are used exclusively by a single cloud service customer and resources are controlled by that cloud service customer.

**3.1.20 public cloud** [ITU-T Y.3500]: Cloud deployment model where cloud services are potentially available to any cloud service customer and resources are controlled by the cloud service provider.

**3.1.21 resource management** [ITU-T Y.3520]: The most efficient and effective way to access, control, manage, deploy, schedule and bind resources when they are provided by service providers and requested by customers.

**3.1.22 role** [ITU-T Y.3502]: A set of activities that serves a common purpose.

**3.1.23 service level agreement (SLA)** [ITU-T Y.3500]: Documented agreement between the service provider and customer that identifies services and service targets.

NOTE 1 – A service level agreement can also be established between the service provider and a supplier, an internal group or a customer acting as a supplier.

NOTE 2 – A service level agreement can be included in a contract or another type of documented agreement.

**3.1.24 software as a service (SaaS)** [ITU-T Y.3500]: Cloud service category in which the cloud capabilities type provided to the cloud service customer is an application capabilities type.

## **3.2 Terms defined in this Supplement**

None.

#### **4 Abbreviations and acronyms**

This Supplement uses the following abbreviations and acronyms:

AC	Alternating Current
BaaS	Back-up as a Service
CaaS	Communications as a Service
CAPEX	Capital Expenditure
CompaaS	Compute as a Service
CSC	Cloud Service Customer
CSP	Cloud Service Provider
DaaS	Desktop as a Service
DC	Direct Current
DraaS	Disaster Recovery as a Service
DSaaS	Data Storage as a Service
IaaS	Infrastructure as a Service
ICT	Information and Communication Technology
IT	Information Technology
IXP	Internet Exchange Point
LAN	Local Area Network
M&E	Mechanical and Electrical
NaaS	Network as a Service
OPEX	Operational Expenditure
PaaS	Platform as a Service
PCI DSS	Payment Card Industry Data Security Standard
PUE	Power Usage Effectiveness
QoS	Quality of Service
SAN	Storage Area Network
SaaS	Software as a Service
SMB	Small and Medium Businesses
SDO	Standard Development Organization
SLA	Service Level Agreement
UI	Uptime Institute
UPS	Uninterruptible Power Supply
VAS	Value Added Services

#### **5 Conventions**

None.

## 6 Overview

According to [ITU-T Y.3500], cloud computing has been defined as "A paradigm for enabling network access to a scalable and elastic pool of shareable physical or virtual resources with self-service provisioning and administration on-demand."

### 6.1 Key characteristics

Cloud computing is a dynamic concept that keeps evolving. According to [ITU-T Y.3500], the key characteristics of cloud computing include:

- i) on demand access which allows cloud service customers (CSCs) to make use of the resources as and when required;
- ii) cost effectiveness as it readily reduces the capital expenditure (CAPEX) of organizations allowing them to divert resources to operational expenditure (OPEX);
- iii) high scalability as it offers little time to implementation enabling the CSCs to promptly customize and adjust the cloud computing capabilities according to their needs;
- iv) energy saving as the same resources are being utilized by multiple tenants; and
- v) increased level of convenience as only broadband internet access is required which can be accessed over a varied range of terminals such as tablets, laptops, workstations and mobile phones.

### 6.2 Deployment models

According to [ITU-T Y.3500], the cloud economy consists of various cloud service deployment models and service categorises. The cloud computing deployment models are described in the Table 6-1.

**Table 6-1 – Cloud computing deployment models**

<b>Model</b>	<b>Description</b>
<b>Private cloud</b>	Proprietary resources provided for a single organization (for example, a government or large enterprise), managed and hosted internally or by a third-party.
<b>Public cloud</b>	Open resources that offer services over a network that is open for public use. Many mass market services widely used by individuals, such as webmail, online storage and social media are public cloud services.
<b>Hybrid cloud</b>	A mix of the deployment models for example, public and private cloud provision.
<b>Community cloud</b>	Resources/services provided for and shared by defined CSCs who have similar requirements and a relationship with one another. This is managed and hosted internally or by a third-party or a combination of both.

### 6.3 Service categories

The representative services offered on the cloud platform are described below [ITU-T Y.3500]. As the sector evolves, other services will soon be offered on this platform.

**Table 6-2 – Cloud platform service categories**

<b>Service category</b>	<b>Description</b>
<b>Communicate as a service</b>	Audio/video communication services, collaborative services, unified communications, e-mail, instant messaging, data.
<b>Compute as a service (CompaaS)</b>	Cloud service category in which the capabilities provided to the cloud service customer are the provision and use of processing resources needed to deploy and run software.
<b>Data storage as a service (DSaaS)</b>	Cloud service category in which the capability provided to the cloud service customer is the provision and use of data storage and related capabilities.
<b>Infrastructure as a service (NaaS)</b>	Virtualized on-demand server, virtualized data centre, flexible on-demand storage space, flexible local area networks (LANs), firewalls, security services, etc.
<b>Network as a service (NaaS)</b>	Platform for cloud computing service provision, virtualized network (customer service management, billing, on-demand bandwidth etc.)
<b>Platform as a service (PaaS)</b>	Applications built on top of cloud service provider's infrastructure. Developers can derive benefit from PaaS.
<b>Software as service (SaaS)</b>	Business applications, customer relations and support (CRM), HR, finance (ERP), online payments, electronic marketplace.

#### **6.4 Benefits of cloud computing**

According to the report by [b-ITU-D Q3/1], "Access to Cloud Computing: Challenges and opportunities for developing countries", Cloud computing adoption offers tangible benefits in terms of cost reduction, flexibility, agility, scale, and innovation.

Cloud technologies enable businesses and governments to consolidate their investments, their servers and data centres to reduce their costs. For small and medium businesses (SMBs), cloud computing is an opportunity to get access, at a fraction of cost, to the latest technologies which were previously only accessible to large enterprises, and without having to worry about technical infrastructure that is not core to their business. This enables them to better compete with any other business on the globe. Cloud computing allows businesses and governments to become more flexible and agile by allowing them to build new products and services much faster. This also gives an opportunity to small start-ups to participate in the industry with their innovations.

#### **7 Questionnaire findings**

An ITU-T survey was commissioned to assess the current profile of cloud computing deployment in developing countries. To this effect two questionnaires on cloud computing status in developing countries were formulated. The first questionnaire was designed for cloud service customers (CSC) and the second one for cloud service providers (CSP). The questionnaires were made available in word document format and online to facilitate a wide range of feedback methods for the respondents. In May 2016 they were disseminated to ITU members from developing countries with a request to share the questionnaires with the CSCs and CSPs in their countries, including entities which were not ITU-T members.

Eight (8) responses were received for the CSC questionnaire and eighteen (18) for the CSP questionnaire from seventeen (17) countries. The majority of responses were from Africa as highlighted in the appendices and Table 7-1.

**Table 7-1 – List of countries and responses obtained**

No.	Country	Number of CSP respondents	Number of CSC respondents	Total
1	Afghanistan	1	0	1
2	Algeria	1	0	1
3	Bosnia and Herzegovina	1	0	1
4	Botswana	1	0	1
5	Burkina Faso	1	0	1
6	Cote d'Ivoire	1	0	1
7	Gambia	1	0	1
8	Ghana	1	1	2
9	Malawi	1	1	2
10	Nigeria	1	0	1
11	Senegal	1	0	1
12	Sudan	1	1	2
13	Trinidad and Tobago	0	1	1
14	Tunisia	1	0	1
15	Uganda	0	1	1
16	Zambia	2	1	3
17	Zimbabwe	3	2	5
	<b>Total</b>	<b>18</b>	<b>8</b>	<b>26</b>

The questionnaires covered the following main axes:

- a) availability of reliable internet services over which the cloud services may be accessed;
- b) deployment and usage of cloud based services;
- c) degree of implementation of standards and service level agreements;
- d) degree of infrastructure deployment;
- e) levels of data privacy and cloud security;
- f) cloud computing training requirements;
- g) factors that affect the deployment and usage of cloud computing services; and
- h) factors that may motivate the uptake of cloud computing services in developing countries.

### 7.1 Questionnaire respondents

Of the respondents under CSCs:

- seventy five per cent (75%) were government institutions;
- thirteen per cent (13%) were corporate intuitions; and
- thirteen per cent (13%) were multinational companies.

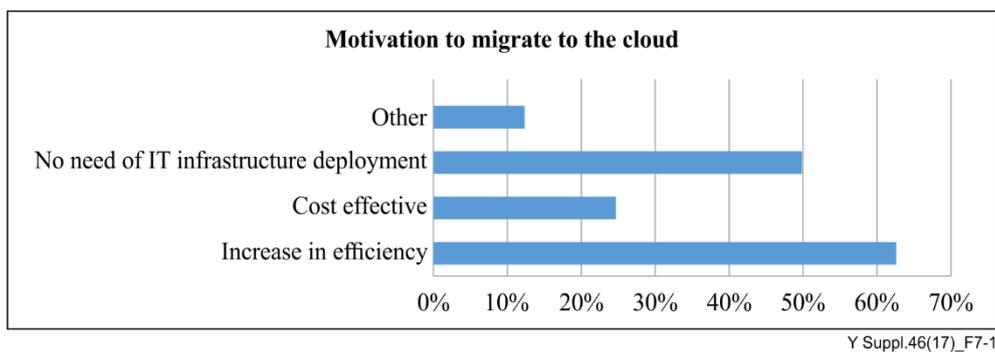
On the other hand respondents under CSPs:

- thirty three per cent (33%) of CSP respondents also provided mobile services and fixed services; and
- twenty eight per cent (28%) also provided Internet services.

## 7.2 Deployment of cloud computing in developing countries

The main motivation for most CSCs to migrate to the cloud is the increase in operational efficiency. Furthermore, cloud computing services free them from the need to acquire expensive hardware and to deploy information technology (IT) infrastructure ultimately ensuring cost optimization.

The deployment requirements for customers to access cloud services from the CSPs are relatively simple as customers are only required to pay for licence fees, where applicable, as well as to have a reliable internet connection. It is also imperative that customers have a resilient power supply for the cloud computing services to be provided with minimum disruption.

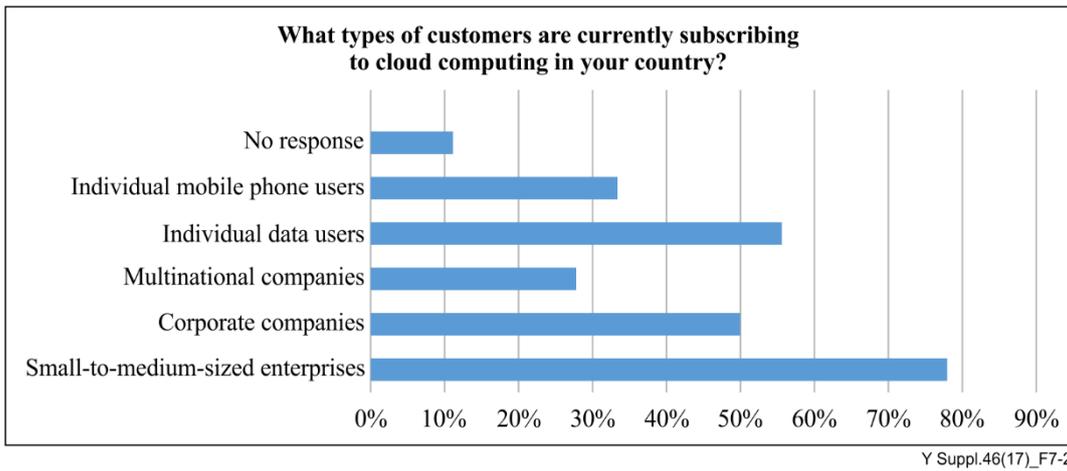


**Figure 7-1 – Motivation to migrate to the cloud**

In addition to the aforementioned motivations, respondents indicated the following motivations for migrating to the cloud:

- scalability in an instance;
- flexibility to switch vendors and platforms with minimal notice without cost overruns;
- resilience and an overwhelming degree of reliability;
- resource conservation owing to workforce redundancy;
- absence of wasted capacity, routine server maintenance or daily backup issues;
- data security and protection from denial of service attacks and spam;
- statutory compliance when housing and processing medical or government data;
- guaranteed uptime and SLA; and
- access to the latest licensed software and infrastructure without having to pay for it entirely.

Most CSPs have engaged in cloud service provision in order to provide their customers with an affordable solution that minimizes their infrastructure investment costs and has faster time to market. At the same time, the CSPs have been motivated to provide customer on-demand services in order to meet the needs of their customers who want to access these services at their convenience.

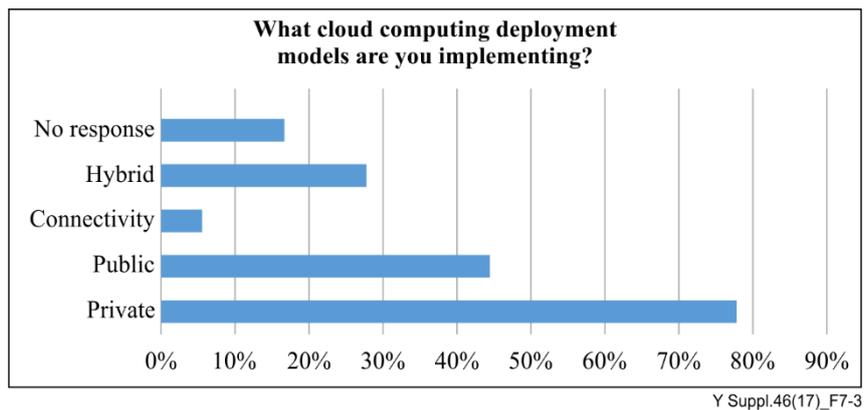


**Figure 7-2 – Types of customers subscribing to cloud computing**

The target market for most providers is skewed towards providing solutions to small-to-medium sized enterprises that want to minimize their infrastructure cost or completely outsource the data management services. Some relatively bigger corporate companies and organizations that include private and government institutions also use the cloud services motivated by the need to have some cost effective and efficient way of deployment of IT services.

The services mainly being offered by the CSPs include:

- online customer support;
- data storage through virtual private servers;
- mail hosting;
- communication and collaboration services;
- software as a service relating to business application such as accounting and human resource management; and
- infrastructure as a service.



**Figure 7-3 – Implemented cloud computing models**

### Case study: Senegal

Senegal is at the stage where information is being gathered by various experts to try and guide developments in cloud computing in the country. Specifically, some of the country's ICT operators have begun to implement or are already using cloud computing. At present, the application of cloud computing is mostly by big corporate organizations like banks. Many operational and regulatory issues such as policy implementation, licensing and security still remain unclear. Senegal would want to holistically provide an environment which promotes the availability of this service to many users.

### Case Study: Zambia

In Zambia, there are about seven (7) cloud service providers already providing or in the process of offering cloud computing services to the public. Only one (1) of these providers has cloud computing as its core business. The other providers offer cloud computing services as value added services (VAS) to which they obtain a license from the ICT regulator, ZICTA.

## 7.3 Applications and services

The common cloud computing applications and services in use include:

- data storage;
- platform as a service; and
- software as a services.

The most salient service is infrastructure as a service (IaaS) which has demonstrated to be the most promising cloud computing solution. Other promising applications are:

- SaaS
- PaaS
- CaaS
- NaaS
- Data Storage

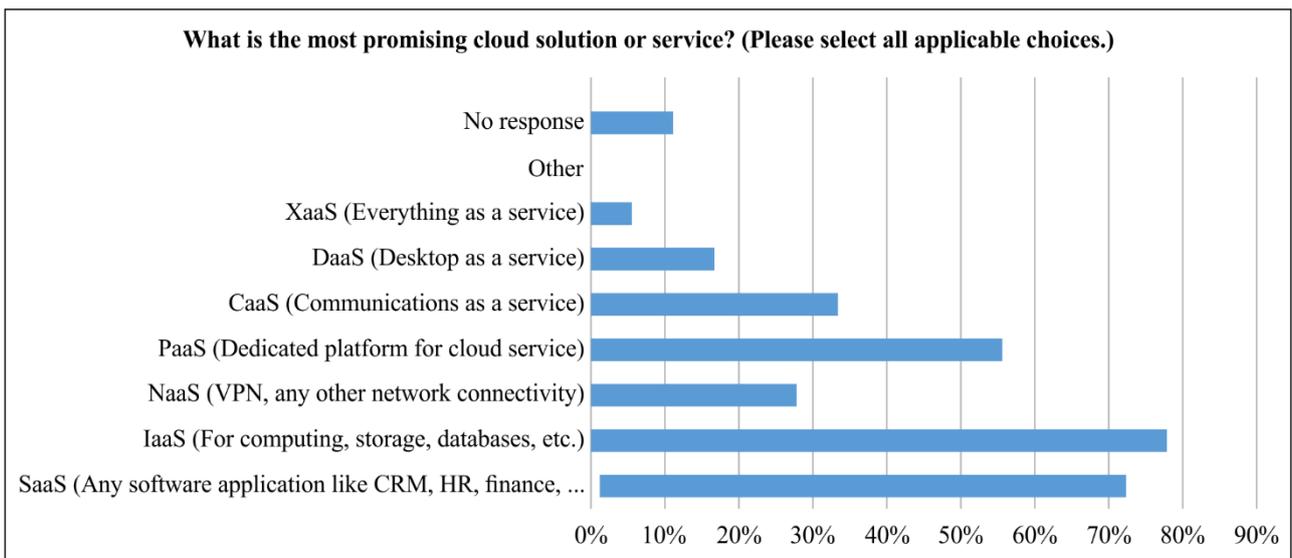


Figure 7-4 – Popular cloud computing services

## 7.4 Infrastructure requirements

Cloud related infrastructure that facilitate the access to or the transmission of cloud data include broadband infrastructure, internet exchange points (IXPs) and reliable electricity supply. Broadband connectivity is the prominent requirement that will enable access to cloud computing services

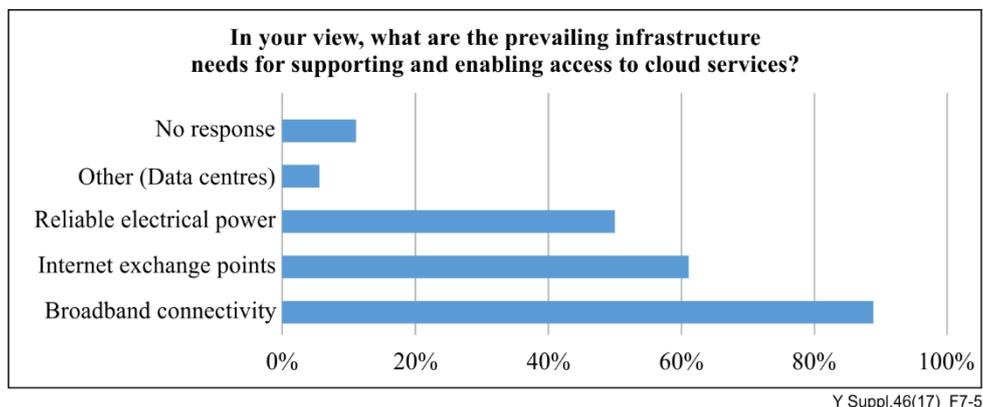


Figure 7-5 – Infrastructure requirements

## 7.5 Costs associated with cloud computing adoption

Cloud computing enables access to a multitude of services on the Internet. Thus, costs associated with cloud computing adoption depend on the context such as the deployment model, the service category and many others parameters including:

- licence fees;
- training on how to access cloud services;
- set up configurations; and
- Internet connection.

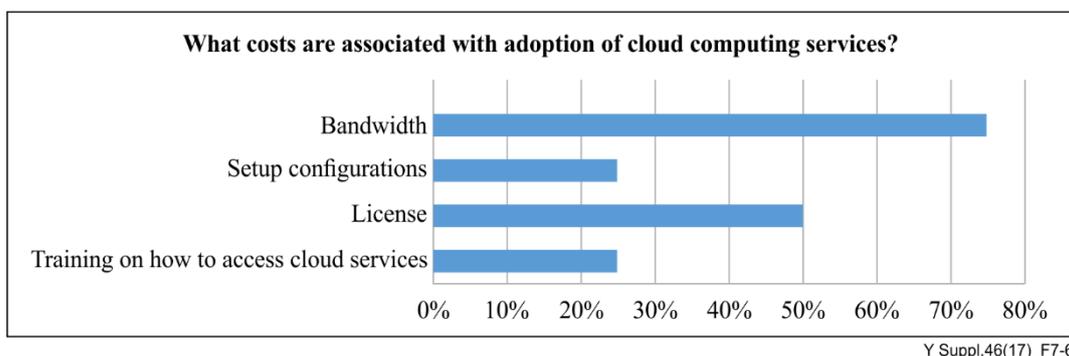


Figure 7-6 – Cost for adoption of cloud computing

## 8 Cloud computing requirements in developing countries

### 8.1 Standardization requirements

Several efforts are being made by various standards developing organizations (SDOs) to develop cloud computing standards that will foster the adoption of cloud computing services. Standards will set a benchmark that will be used to assess and select the most apt cloud computing solution for a given requirement.

There is need for fervent standardization of cloud computing in developing countries to enable the ease and flexible adoption of cloud computing and to optimize the use of this technology in these

countries. Standards will also help to circumvent the possible vendor or operator lock-in of CSCs. The different aspects of the standards that need to be considered are as highlighted.

### **8.1.1 Cybersecurity**

ITU has developed several recommendations on security in the cloud. The recommendations developed hitherto include:

- Security framework for cloud computing [ITU-T X.1601] which analyses security threats and challenges in the cloud computing environment and describes security capabilities that could mitigate these threats and address security challenges.
- Recommendation [ITU-T X.1602] on security requirements for software as a service application environments which analyses the maturity levels of SaaS application and proposes security requirements to provide a consistent and secure service execution environment for SaaS applications.
- Information technology – Security techniques ([ITU-T X.1631]) – Code of practice for information security controls based on [ISO/IEC 27002] for cloud services. This recommendation provides guidelines for information security controls applicable to the provision and use of cloud services for both CSPs and CSCs.
- Generic security guidelines for the cloud service customer (CSC) data in cloud computing are provide in [ITU-T X.1641]. This Recommendation also analyses the CSC data security lifecycle and proposes security requirements at each stage of the data lifecycle. Furthermore, it provides guidelines on when each control should be used for best security practice.
- Recommendation [ITU-T X.1642] on guidelines of operational security for cloud computing provides generic operational security guidelines for cloud computing from the perspective of cloud service providers (CSPs). A set of security measures and detailed security activities for the daily operation and maintenance are provided to help CSPs mitigate security risks and address security challenges for the operation of cloud computing.

### **8.1.2 Interoperability and portability**

Cloud computing offers a diverse range of products and services such as IaaS, DaaS and SaaS as well as varied range of platforms on which these products and services are delivered and accessed. In order for these applications and services to work in tandem, there will be need for a prescribed set of rules that will ensure the synergistic application of these services and to also prevent vendor lock-in. Interoperability and portability standards will ensure that customers make the best use of the various cloud computing services and platforms that are available and that these products and services are able to cooperate and inter-work.

### **8.1.3 Service level agreements (SLA)**

Most CSCs have signed service level agreements with their cloud service providers. The following are some of the benchmarks of the cloud computing applied in SLAs.

- Security and privacy of data
- Data ownership
- Accountability
- Flexibility
- Cost
- Performance
- Confidentiality
- Usability
- Support

- Service availability
- Quality of service
- Contract management
- Provisioning time
- Dispute process
- Applicable law

The multiple aspects of SLAs exemplify the need to have them standardized and this has also been generally expressed by most CSCs and CSPs. The relevant aspects that need to be standardised in SLAs include quality of service (QoS), data security and privacy, confidentiality and service availability.

#### **8.1.4 Green standards**

There is a global paradigm shift towards enabling environmental sustainability in all sectors of the economy. This is being achieved through a number of initiatives and technological innovations and advancements. Cloud computing is one such innovation that is envisaged to contribute significantly towards achieving environmental sustainability through resource pooling. However, the increasing demand for cloud services has drastically increased the energy consumption of data centres, subsequently challenging the energy efficiency of these data centres.

Many strides are being made to ensure that the deployment of cloud computing infrastructure such as data centres does not negate the benefits of the cloud computing technology and exacerbate the negative impact of cloud services on the environment. ITU has developed a number of recommendations that will support energy optimization in data centres. These include:

- [ITU-T L.1300] which describes best practices aimed at reducing the negative impact of data centres on the climate. The application of the best practices defined in this Recommendation can help owners and managers to build future data centres, or improve existing ones, and to operate in an environmentally responsible manner. Such considerations will strongly contribute to a reduction of the impact of the information and communication technology (ICT) sector on climate change.
- [ITU-T L.1301] which establishes a minimum data set necessary to manage data centres and telecommunication rooms in an environmentally responsible manner. The Recommendation specifies the communication interface and defines the parameters to be communicated depending on the type of equipment used in data centres, such as power systems (alternating current (AC)/direct current (DC) and uninterruptible power supply (UPS) and energy distribution), cooling systems and ICT equipment.
- [ITU-T L.1302] which specifies an energy efficiency assessment methodology for data centres and telecom centres, test equipment accuracy requirements, assessment period, assessment conditions and calculation methods.
- [ITU-T L.1320] which contains the general definition of metrics, test procedures, methodologies and measurement profiles required to assess the energy efficiency of power and cooling equipment for telecommunications and data centres.

#### **8.1.5 Other standards**

Other standards would be developed as the need arises.

## **8.2 Human resources**

Inadequate human resources to fully implement and utilise cloud computing services in developing countries has been identified as a constraint. In order to make cloud computing services a reality in

developing countries, there is need to build human capacity and to develop the relevant skills in the following areas:

- standards development;
- auditing of cloud service provision to ensure compliance with the relevant regulations;
- management of the cloud infrastructure and service provision to enable a smooth migration and integration of cloud services as well as the execution of other legal and business processes;
- regulation of the various facets of cloud service provision such as infrastructure installation and management;
- cyber-security, service delivery and data protection; and
- cloud applications development to create new opportunities for new services.

### 8.3 Data centres

Data centers are considered as one of the infrastructure requirements for supporting and enabling access to cloud services. For this purpose, the establishment of data centres in developing countries should take into account some pillars, including the following:

- **high availability:** Service continuity and high availability of data centres infrastructure, based on Tier III specifications of the [TIA-942 Standard], should be ensured;
- **security:** Data centres should be aligned with international data Centre security standards (physical and environmental safety, technical security, ...);
- **energy efficiency:** Ensuring the energy efficiency of data centres by increasing cooling efficiency and reducing power consumption is essential. Redundancy of power and cooling supplies should also be guaranteed;
- **cloud readiness:** In addition to the usual data centre services (such as dedicated private area, dedicated rack or colocation, dedicated server,...), data centres would be scalable and ready to support a wide range of cloud services such as virtual private server, virtual private cloud, cloud back-up, virtual load-balancer, virtual firewall, web hosting and elastic storage. For this reason, data Centres should ensure higher connectivity to LANs and storage area networks (SANs) and use virtualization for multi-tenancy; and
- **service operation centre:** The management of processes and functions of data centers should be controlled by a dedicated service operation centre, which will mainly take in charge the management of access, events, requests, incidents, service desk 24x7, technical components, applications and IT operations.

As adoption increases, cloud services will continue to drive the evolution of several aspects of data centres in developing countries, from architecture to software and control processes.

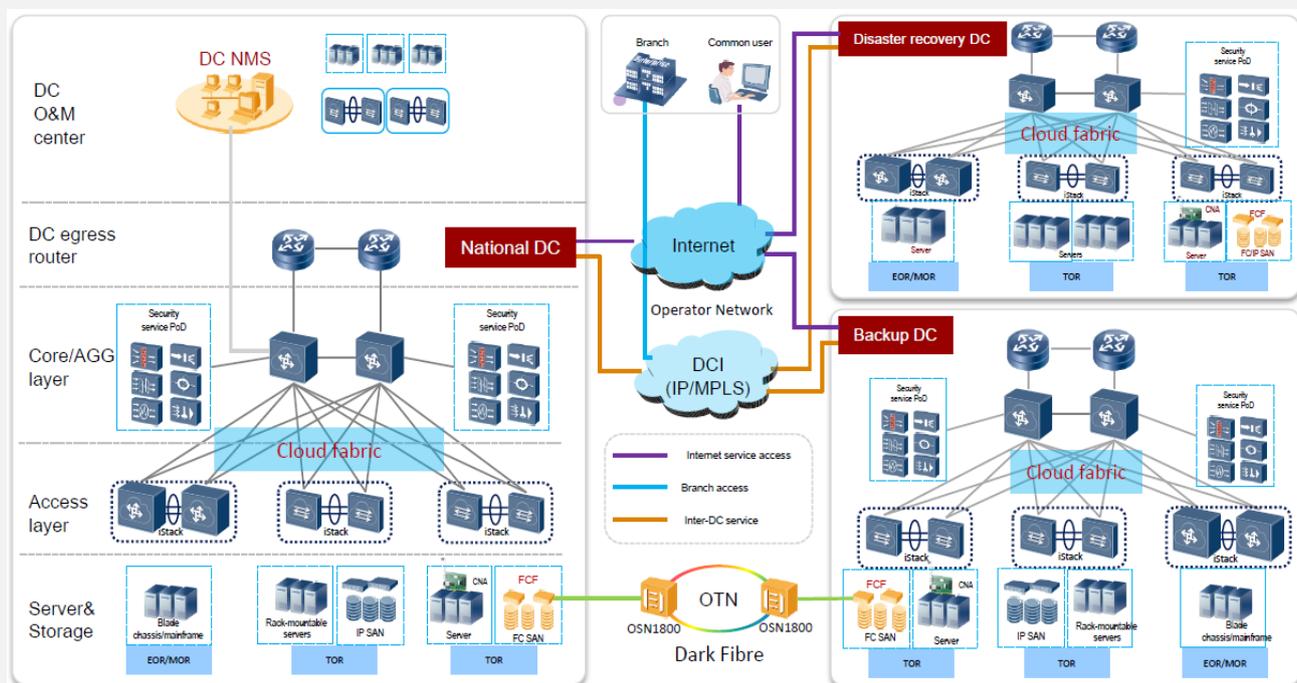
#### 8.3.1 Data centres – Case studies

## Case study 1: National data Centres in Zambia

Zambia has established a government owned cloud service provider, the Zambia National Data Centre Limited (ZNDC). This is a company limited by guarantee through the ICT regulator, Zambia Information and Communications Technology Authority (ZICTA). The establishment of the ZNDC with three geo-located data centres will provide a platform for both government and private sector to consume secure, highly reliable and available cloud Services from the Tier III Uptime certified data centre.

The data centres are not just traditional data centres offering reliable power and cooling services only. They are modular data centres built on cloud architecture with virtualization as the bedrock. The three data centres provide on demand cloud services such as e-mail as a service, infrastructure as a service (IaaS), back-up as a service (BaaS), disaster recovery as a service (DraaS) and platform as a service (PaaS).

The high level topology of the data centres is shown in Figure 8-1:



**Figure 8-1 – High-level topology of data Centres**

The national data centre has three sites that are located in geographically spread areas with a combined floor space of 1,600 square metres. The sites were chosen based on the country spread so that one site in the northern part of the country can serve the northern region of the country while the other two will serve the central and southern part of the country.

The data centres are designed for an average power usage effectiveness (PUE) of 1.3. The facility has a combined rack count of 206 with 24/7 network operation centre technicians and mechanical and electrical (M&E) staff.

The data centres are built to Tier III standard with multiple dark fibre and MPLS links, multiple DWDM and dual full stack IPv4 and IPv6 support.

The Zambia National Data Centre is cognisant of the challenges affecting cloud computing uptake in the country. Among the challenges is connectivity. The data centres have been declared as carrier neutral data centres allowing all ISPs and carriers in the country to form a local traffic fabric loop at the data centres. With this, data centre clients have a choice of Internet service providers to choose from as and when service level agreements (SLAs) are not met.

In cognizance of security challenges, measures have been taken to mitigate these challenges by adopting best practices from regional data centres in Kenya and South Africa. The data centres have adopted ISO 27001 and is in the process of undergoing the payment card industry data security standard (PCI DSS) to optimise security as the centre will handle financial data.

In order to increase client confidence and trust, the ZNDC facilities are undergoing Tier III certification with the Uptime Institute (UI) to guarantee availability and operational and sustainability of the facility.

### **Case study 2: Tunisie Télécom**

Tunisie Télécom, the incumbent telecom operator in Tunisia, considers data Centres as an extension of its infrastructure to support the convergence of communication and information technologies. In this regard, Tunisie Télécom has built, to date, three data centres, as follows:

#### **a) Primary data center: Carthage Data Centre**

Located in the northern suburb of the capital Tunis, and inaugurated in October 2013, this data centre, is the largest data centre of Tunisie Télécom (space of the data centre: 2 700 m<sup>2</sup>, hosting space: 660 m<sup>2</sup>) and it has the largest capacities among Tunisie Télécom's data Centres in terms of hosting (200 racks), energy and connectivity.

This data Centre is ISO 27001-certified (*Information Security Management System*) since May 2016 and it is compliant with the specifications of ISO 14001 (*Environmental Management System*) and Tier III certifications (the process of request of these two certifications is ongoing). Carthage Data Centre is currently hosting the cloud computing platform of Tunisie Télécom as well as data for many clients from Tunisia.

#### **b) Secondary data centre: Kasba Data Centre**

This data centre is located in the capital Tunis, around 20 km from the primary data Centre. It was the first data centre established by Tunisie Télécom over an area of 280 m<sup>2</sup>. This data centre is hosting the SaaS platform of Tunisie Télécom.

#### **c) Disaster recovery data centre: Kairouan Data Centre**

This data centre was recently established and it is located in the western region of the country, around 160 km from the primary data centre. It is used for disaster recovery and it guarantees a physical and geographical redundancy.

Each data centre is compliant with [TIA-942 standards], and each of them is connected with at least two different fibre links to Tunisie Télécom's MPLS Backbone to ensure redundancy (10 Gbit/s fibre links for Carthage and Kairouan Data Centres and 1 Gbit/s fibre links for Kasba Data Centre).

## **8.4 Electricity supply**

Over 50 per cent of the CSP questionnaire respondents indicated that electricity supply is one of the main challenges for the provision of cloud computing services.

The problems of electricity supply in most developing countries are similar and are usually three fold:

- i) **limited access:** Vast areas of many developing countries have limited access to electricity.
- ii) **costly:** Where electricity is available, it is usually expensive.
- iii) **poor quality:** Electricity in most developing countries is of poor quality and intermittent.

Power may raise the operational cost for CSP while on other hand it may contribute to poor quality of service if it is not reliable. These issues must be resolved if developing countries are to enjoy the benefits of cloud computing services.

## 8.5 Network infrastructure

According to the findings of the questionnaires, broadband connectivity was identified by CSPs as the most prevailing infrastructure requirement to support and enable access to cloud services.

In fact, cloud computing performance depends on consumer's Internet connection, used to access cloud services. With a huge amount of data stored in the cloud, connections need to be high-speed and reliable in order to allow cloud computing resources to be easily distributed, and without enough bandwidth, the delivery of cloud computing services would not be feasible. Unfortunately, consumers' access to affordable broadband Internet is still not satisfactory in many developing countries, especially in the least developed countries. Most of these countries rely on mobile broadband networks which are in many cases characterized by low speed and high latency and consequently are not suitable for cloud service delivery especially for applications such as video-streaming and real-time computing.

Moreover, cloud performance closely depends on network performance. For this reason, and in order to provide a real added value for cloud services, the network components for cloud services composition and delivery should meet a number of requirements in terms of flexibility, scalability, and on-demand resource provisioning, and offer the necessary advanced network functions to guarantee performance, security and availability of cloud services.

According to [ITU-T Y.3510], there are several types of networks involved in cloud computing services delivery and composition, such as:

- i) **intra-datacentre network**, which is the network connecting local cloud infrastructures, such as the data centre local area network use to connect servers, storage arrays and L4-L7 devices (e.g., firewalls, load balancers, application acceleration devices);
- ii) **access and core transport network**, which is the network used by CSCs to access and consume cloud services deployed by the CSP; and
- iii) **inter-datacentre network**, which is the network interconnecting remote cloud infrastructures, taking into account that these infrastructures may be owned by the same or different CSPs.

[ITU-T Y.3510] listed a number of requirements for the networking resources of each of the access and core transport networks, intra-datacentre networks and inter-datacentre networks. However, some general requirements are applicable on the three types of networks where networking resources should be scalable, ensure services' performance and availability in order to meet SLA objectives, be able to adapt dynamically to the traffic generated by cloud services, support IPv4 and IPv6 and support policy based control on flow by flow basis in a fine-grained manner.

### **Case study: Network connectivity at Tunisie Télécom's Carthage Data Centre**

In order to ensure performance, security and availability of cloud services, Carthage Data Centre is connected with two different high-speed fibre links to Tunisie Télécom's IP MPLS Backbone (10 Gbits/link). The two links are completely different in order to guarantee redundancy and access continuity without any interruption (different access points at the data centre level, different paths to the IP MPLS Backbone, different PoP's locations, etc.).

Carthage Data Centre is also interconnected with the two other data centres of Tunisie Télécom (Kairouan Data Centre for disaster recovery, and Kasba Data Centre).

Besides, Tunisie Telecom has deployed all means (VRF, VLAN, Firewalls, anti-DDos protection, etc.) and procedures to prohibit any fraudulent connection on the private networks of customers.

## 8.6 Trust

One of the issues affecting the implementation of cloud computing services in developing countries relates to the mistrust of cloud computing services, which in its nature generally puts a curtain wall between the CSP and the CSC. Potential users of cloud computing services will accept the "curtain wall" if there is strong evidence that the CSP on the other side of the "curtain" can be trusted. For that to happen there should be conditions which must be agreed upon and met by the CSP to assure the CSC that they can be trusted.

The development of those conditions and the framework of meeting them can be complicated if left up to the CSP and CSC to handle. However, if the efforts of international standardization organizations such as ITU produces recommendations on trust, both the CSP and CSC are more likely to feel comfortable to work with such recommendations.

The current cloud computing trust and security issues are closely related. In fact the uptake of cloud computing services in developing countries can suddenly increase by merely making stakeholders aware that issues of trust are different from those to do with security and show them how they are handled without confusing the two.

The ITU has already developed Recommendations such as [ITU-T Y.3514], "Cloud Computing – Trusted inter-cloud computing framework and requirements". This Recommendation specifies a framework of trusted inter-cloud computing and relevant use cases. It provides general requirements for trusted inter-cloud and specific ones related to governance, management, resiliency, security and confidentiality of trusted inter-clouds on security in the cloud. It is based on the framework of inter-cloud computing [ITU-T Y.3511].

The scope of this Recommendation includes:

- overview of trusted inter-cloud computing;
- general requirements for trusted inter-cloud;
- requirements for governance of trusted inter-cloud;
- requirements for management of trusted inter-cloud;
- requirements for resiliency of trusted inter-cloud; and
- requirements for security and confidentiality of trusted inter-cloud.

There are other closely related recommendations that ITU-T has developed which are very relevant to issues of trust of the cloud. These include:

- [ITU-T Y-3051] "The basic principles of trusted environment in information and communication technology infrastructure" which is devoted to the issue of creating trusted environment in ICT infrastructure providing information and communication services. The Recommendation provides the definition, common requirements and the basic principles of creating trusted environment.
- [ITU-T Y.3052] "Overview of trust provisioning for information and communication technology infrastructures and services" which provides an overview of trust provisioning in ICT infrastructures and services. It introduces the necessity of trust to cope with potential risks due to lack of trust.
- [ITU-T X.1258] "Enhanced entity authentication based on aggregated attributes"; aggregating attributes from multiple attribute authorities may be needed in order to enable a relying party to enhance its trust in the identity of a party. The aggregation can be regarded as having to deal with a collection of globally unique identifiers, which is common across all attribute authorities.

All ICT stakeholders have a role to play in making cloud computing services more trusted in developing countries. There could be some aspects that may differ from country to country but a common framework could be provided to make it easier for stakeholders to accept them.

It is believed that the more trust issues are handled, the more CSCs will take up cloud computing services.

## **9 Challenges of cloud computing adoption**

The regulation of cloud computing services is not properly defined in most developing countries which greatly inhibits the adoption of cloud services in these countries. The main challenges that have affected the adoption of cloud computing in developing countries include:

### **9.1 Lack of regulatory framework for cloud computing services**

Developing countries lack the regulatory framework to govern the provision and consumption of cloud computing services.

### **9.2 Security and privacy concerns**

Data security and privacy are the most salient challenges associated with the adoption of cloud computing services in developing countries. CSCs tend to be sceptical about handing over their data to a third party. There are concerns of confidentiality of company information, the likelihood of corruption of data and the fate of CSC's data when there is a switch over to another service provider or after termination of the contract. CSPs have a responsibility to demonstrate their credibility as well as to improve awareness on the safety of cloud computing services.

A lot of speculation has been raised on the geographical location of the data centres. CSCs feel they lose control of their data once it is in a location outside their jurisdiction. The local authorities may also not have control over such data. CSCs get concerned regarding how they could be protected in such instances or indeed what each country's strategy could be in this regard.

### **9.3 Infrastructure needs**

Some CSPs highlighted the need to invest more in infrastructure that could provide a broader diversity of cloud computing services as well as increase the capacity of providers to serve more users. This includes the need to deploy data centres, Internet exchange points (IXP) and robust electricity infrastructure sources.

### **9.4 Capacity building**

CSPs highlighted the need for capacity building initiatives on the use, regulation and implementation of cloud computing services as well as the development of cloud computing applications that will create new opportunities for cloud services. The capacity building interventions could be targeted at corporate organizations as well as embedded in the curriculum for schools and tertiary institutions.

### **9.5 Quality of service**

The provision of cloud computing services relies on good quality and reliable Internet services. There has been a general concern from the CSPs and CSCs about the unreliable and low internet connection speed over which cloud services are provided. The lack of IXPs has also resulted in users paying high international bandwidth prices thereby negatively affecting cloud service provision and uptake of cloud services in most developing countries.

### **9.6 Compliance limitations**

Currently, there are no clear policies or regulatory frameworks on the provision of cloud computing services in most developing countries. Equally, there is a lack of standards adoption that will ensure adherence to international best practices for which CSPs could be held accountable. This has had adverse implications on the speedy uptake of cloud computing services.

## **9.7 High cost of broadband Internet**

In its report of September 2017 [b-ITU/UNESCO] "The State of Broadband: broadband catalysing sustainable development", the Broadband Commission projected Internet penetration in developing world to reach 41.3 per cent by the end 2017. Affordability, lack of skills and infrastructure are the reasons among the large gaps in connectivity around the world.

Internet is still not affordable in developing countries and cloud computing can be very expensive, especially in terms of bandwidth consumption, according to 75 per cent of the questionnaire respondents.

Besides the obvious factors, migration to cloud computing could lead to unexpected additional costs according to the [b-ITU-D report] in April 2012 entitled "Cloud Computing in Africa: Situation and Perspectives". Indeed, some operations can be very costly especially if they are not well planned in the timeline. For example, moving large volumes of data to or from the cloud can be very expensive. The same is true of data storage on the cloud for very long periods. Such an operation can be very expensive without the service user realizing it in the short term.

## **10 General recommendations on adoption of cloud computing by developing countries**

General recommendations on cloud computing adoption in developing countries are listed and described as follows:

### **10.1 Regulatory framework**

The provision and uptake of cloud services require an enabling environment respectively for CSPs and CSCs. A number of issues such as cyber security, privacy, data centre location and quality of service have to be looked into to make this possible.

International standardization organizations should participate in developing a model regulatory framework which developing countries can easily adopt.

### **10.2 Standards adoption**

Developing countries are encouraged to adopt/adapt international standards relating to security and trust to stimulate the uptake of cloud computing services.

### **10.3 Basic broadband infrastructure**

Broadband is the main infrastructure requirement to access cloud computing services. As such, it is necessary to ensure that broadband infrastructure is developed as the bedrock for cloud services to thrive.

Policy makers and regulators should put in place policies and regulations that support the development of broadband infrastructure.

### **10.4 Internet exchange points**

IXP can reduce the exchange of data between CSPs.

It is recommended that developing countries consider the establishment of national and regional IXP.

### **10.5 Reliable electricity**

Electricity is one of the main challenges for the provision of cloud computing services.

To benefit from cloud computing services, developing countries have to resolve the problems of inaccessibility, unaffordability and poor quality of electricity.

## **10.6 Data centres**

It is generally recommended that data centres should be of an appropriate tier-level in order to offer the necessary redundancy and resilience to the cloud computing services.

The end result would be a win-win scenario where CSPs will have enough customers to sustain their businesses and CSCs would lower their OPEX and have the reduced burden of maintaining own computing resources.

## Appendix I

### Presentation of the results of the questionnaires for cloud service customers

#### I.1 List of responders

Eight responses were received from seven different countries.

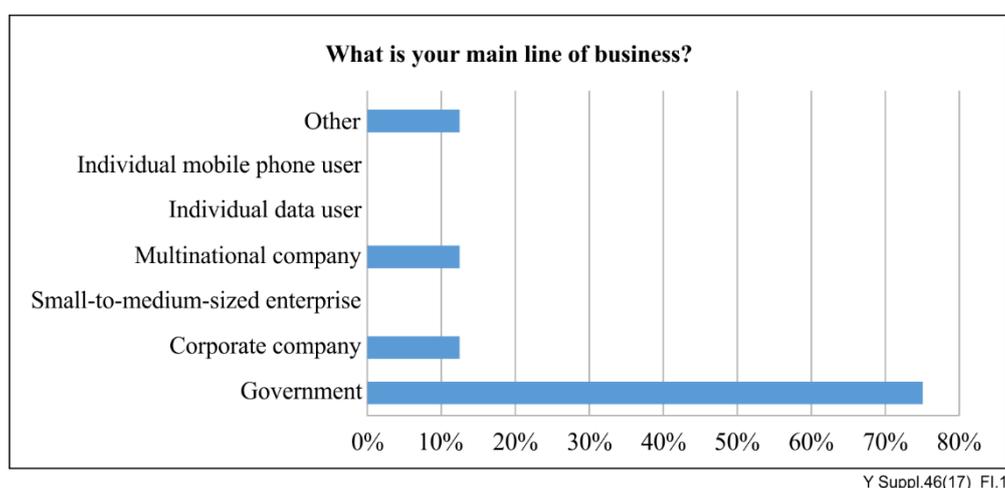
**Table I.1 – List of respondents**

	Organization	Country	Submission
1	NCA	Ghana	By e-mail
2	Bank of Zambia	Zambia	By e-mail
3	Telecommunications Authority of Trinidad and Tobago	Trinidad and Tobago	By e-mail
4	Liquid Telecom	Zimbabwe	By e-mail
5	Telecel Zimbabwe	Zimbabwe	By e-mail
6	National Telecommunications Corporation Sudan	Sudan	Online
7	Uganda Communications Commission	Uganda	Online
8	MACRA	Malawi	Online

#### I.2 Responses to the questionnaire

##### 1 General questions

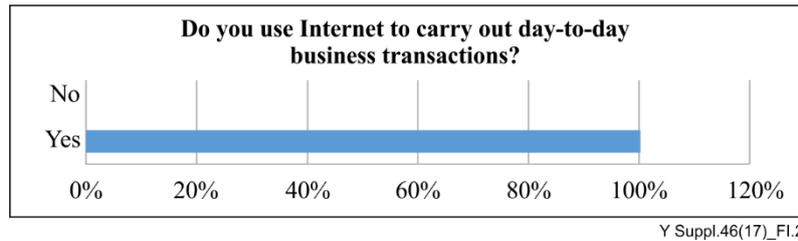
##### 1.1 What is your main line of business?



**Figure I.1 – Respondent's main line of business**

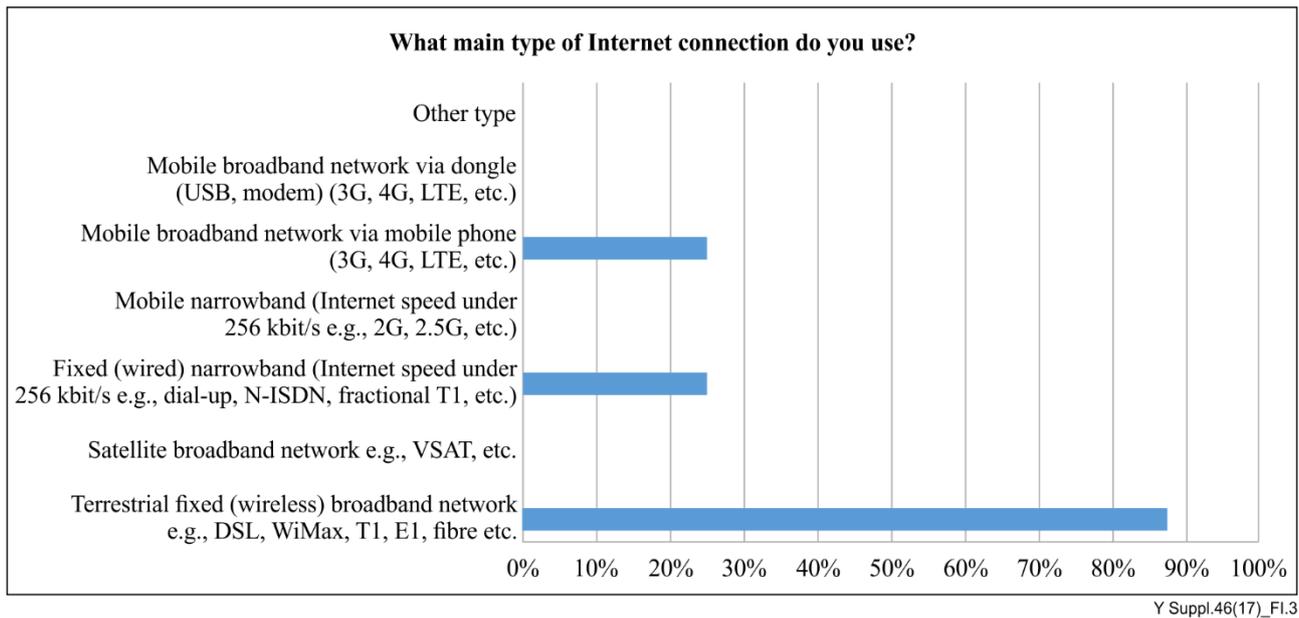
The majority of responders represent the government. There were also responders from a corporate company, a multinational company and an ICT regulator.

**1.2 Do you use Internet to carry out day-to-day business transactions?**



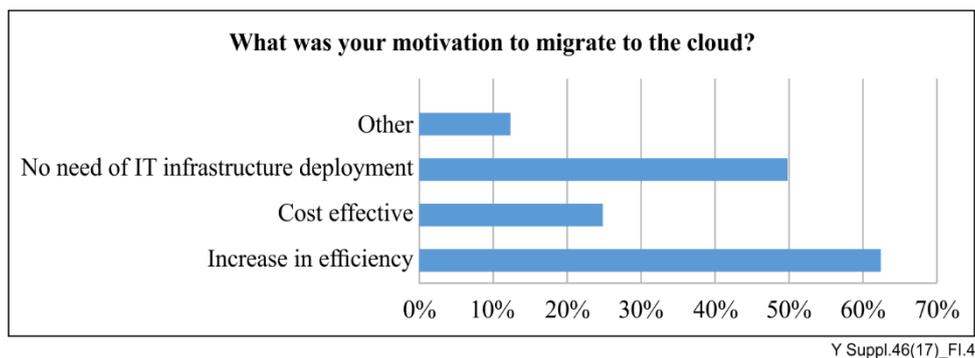
**Figure I.2 – Day-today use of Internet**

**1.3 What main type of Internet connection do you use?**



**Figure I.3 – Type of Internet Connection**

**1.4 What was your motivation to migrate to the cloud?**



**Figure I.4 – Motivation to migrate to the Cloud**

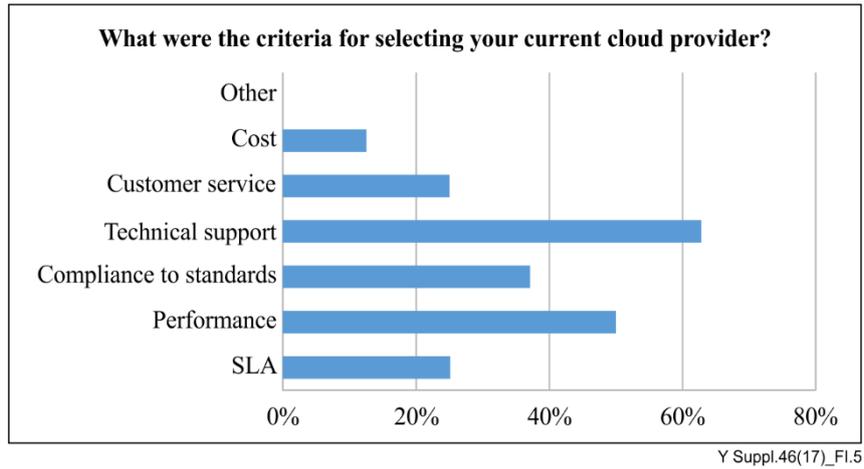
In addition to the three proposed options (increase in efficiency, cost effectiveness and no need of IT infrastructure deployment), responders mention the following motivations to migrate to the cloud:

- scalability in an instance;
- flexibility to switch vendors and platforms with minimal notice without cost overruns;
- resilience and an overwhelming degree of reliability;

- resource conservation owing to workforce redundancy;
- absence of wasted capacity, routine server maintenance or daily backup issues;
- data security and protection from denial of service attacks and spam;
- statutory compliance when housing and processing medical or government data;
- guaranteed uptime and SLA;
- access to the latest licensed software and infrastructure without having to pay for it entirely.

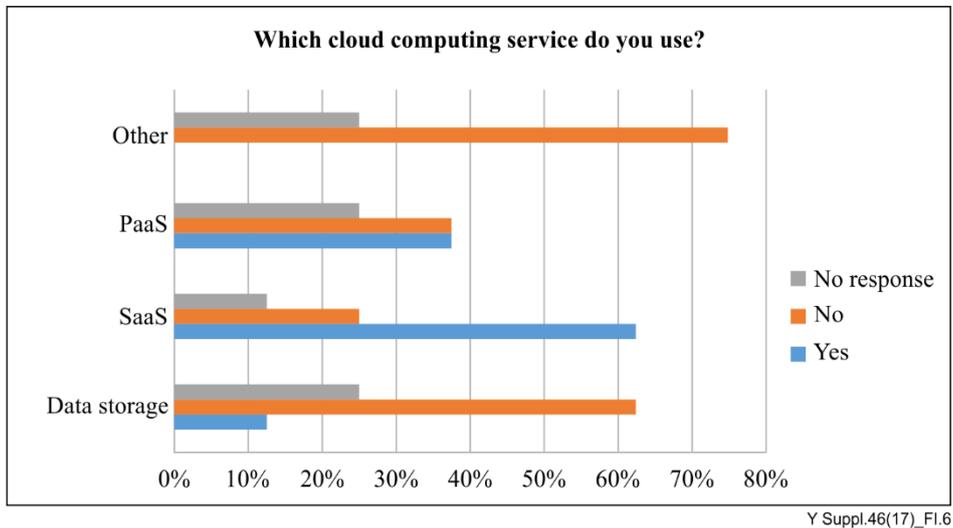
## 2 Cloud computing usage

### 2.1 What were the criteria for selecting your current cloud provider?



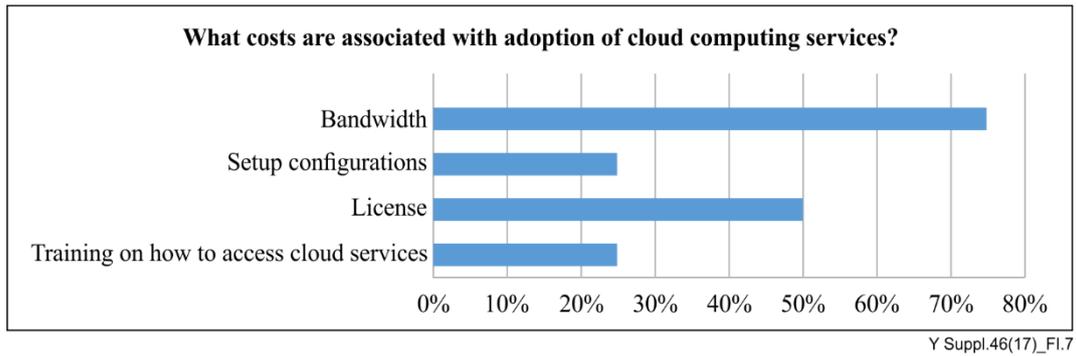
**Figure I.5 – Criteria for selecting CSP**

### 2.2 Which cloud computing service do you use?



**Figure I.6 – Popular cloud computing service**

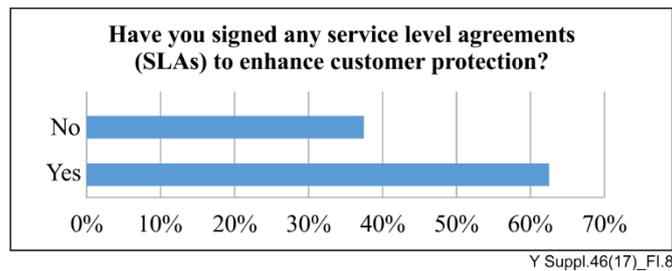
**2.3 What costs are associated with adoption of cloud computing services?**



**Figure I.7 – Cost for deployment of cloud computing services**

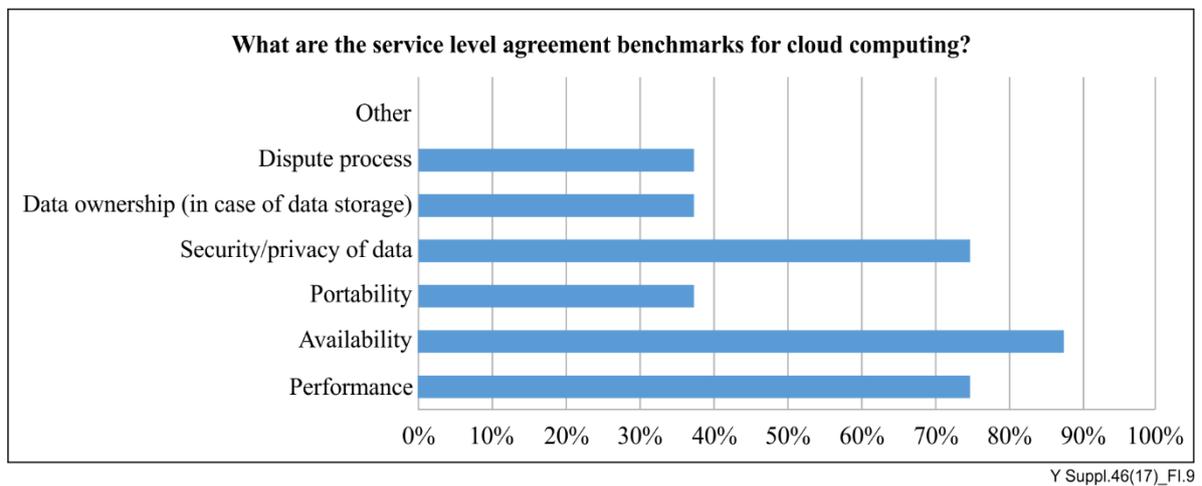
**3 Standardization requirements**

**3.1 Have you signed any service level agreements (SLAs) to enhance customer protection?**



**Figure I.8 – Service level agreements**

**3.2 What are the service level agreement benchmarks for cloud computing?**



**Figure I.9 – Popular SLA benchmarks**

### 3.3 Do you think SLAs should be standardised?

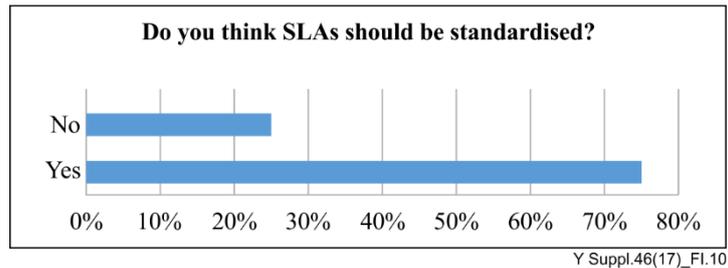


Figure I.10 – Standardization of SLAs

### 3.4 Can you identify some of the issues that are associated with cloud adoption that can be addressed with standards?

Received responses are the following:

- Speed
- Availability
- Data size limit
- Performance
- Portability
- Security/privacy of data
- Data ownership (in case of data storage)
- Dispute process
- Provision of general guidelines so that there is control and uniformity.
- Interoperability

## 4 Opportunities and challenges for cloud computing deployment

### 4.1 What do you think are bottlenecks and weakness that need to be addressed for an effective use of cloud services?

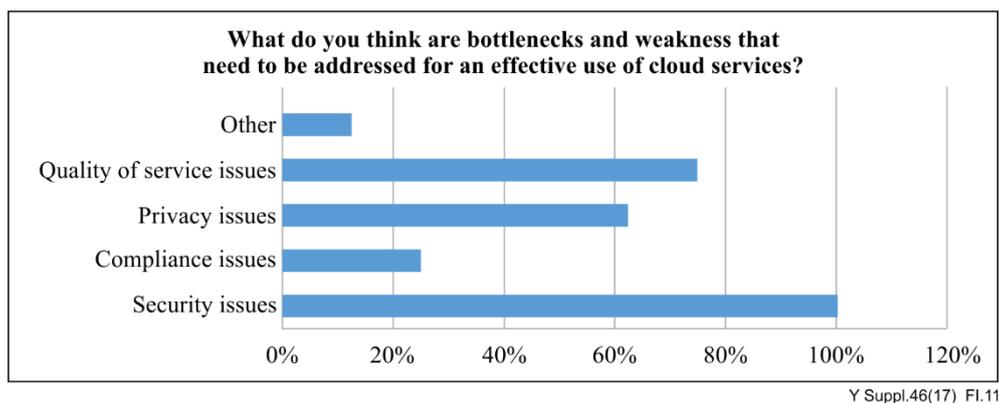


Figure I.11 – Cloud computing bottlenecks

In addition to the provided options, bandwidth availability and affordability were mentioned as bottlenecks and weaknesses that need to be addressed for an effective use of cloud services.

#### **4.2 *What do you think are some of the scenarios that can spur the use of cloud services in your country?***

Received responses are the following:

- The pass of the right to information bill by parliament
- Overall cost savings
- Scalability in an instance
- Flexibility to switch vendors and platforms with minimal notice without cost overruns
- Resilience and an overwhelming degree of reliability
- Resource conservation owing to workforce redundancy
- Increased operational efficiency
- Absence of wasted capacity, routine server maintenance or daily backup issues
- Data security and protection from denial of service attacks and spam
- Statutory compliance when housing and processing medical or government data
- Guaranteed uptime and SLA
- Access to the latest licensed software and infrastructure without having to pay for it entirely
- Reduced cost of Internet service
- Increased privacy and security
- Cost of bandwidth
- The cost of investment in terms of infrastructure versus the use of cloud services
- The fact that services can be accessed and used from anywhere
- For SMEs, this cuts on costs of running the business
- No need to have premises to accommodate all staff
- Efficiency and cost reduction issues can spur the use of cloud services

## Appendix II

### Results of the questionnaire for cloud service providers (CSPs) on cloud computing status in developing countries

#### II.1 List of responders

Eighteen (18) responses were received from 15 different countries, 13 from Africa, one from Europe and one from Asia.

**Table II.1 – List of respondents**

	<b>Organization</b>	<b>Country</b>	<b>Submission</b>
<b>1</b>	Ministry for Digital Economy Development and Post	Burkina Faso	By e-mail
<b>2</b>	Operator	Senegal	By e-mail
<b>3</b>	Complete Enterprise Solutions	Zambia	By e-mail
<b>4</b>	BH Telecom	Bosnia and Herzegovina	By e-mail
<b>5</b>	Microsoft Cote d'Ivoire	Cote d'Ivoire	By e-mail
<b>6</b>	Altostrat Global LTD	Zambia	By e-mail
<b>7</b>	Liquid Telecom	Zimbabwe	By e-mail
<b>8</b>	Telecel Zimbabwe	Zimbabwe	By e-mail
<b>9</b>	CDTA	Algeria	Online
<b>10</b>	National Telecommunication Corporation Sudan	Sudan	Online
<b>11</b>	Ministry of Communications	Nigeria	Online
<b>12</b>	Tunisie Telecom	Tunisia	Online
<b>13</b>	MACRA	Malawi	Online
<b>14</b>	POTRAZ	Zimbabwe	Online
<b>15</b>	PURA	Gambia	Online
<b>16</b>	NCA	Ghana	Online
<b>17</b>	Botswana Communications Regulatory Authority	Botswana	By e-mail
<b>18</b>	Ministry of Communication and Information Technology (MCIT)	Afghanistan	By e-mail

## II.2 Responses to the questionnaire

### 1 General questions

#### 1.1 What is your main line of business?

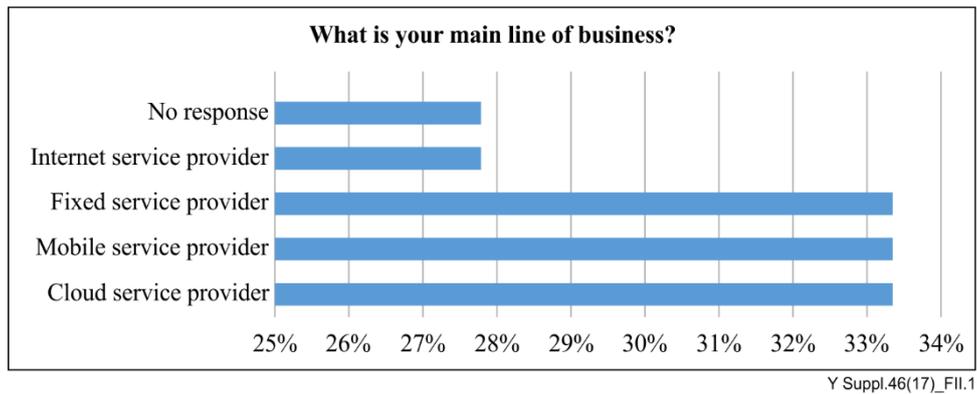


Figure II.1 – Respondent's main line of business

#### 1.2 What means of connections are used in your country?

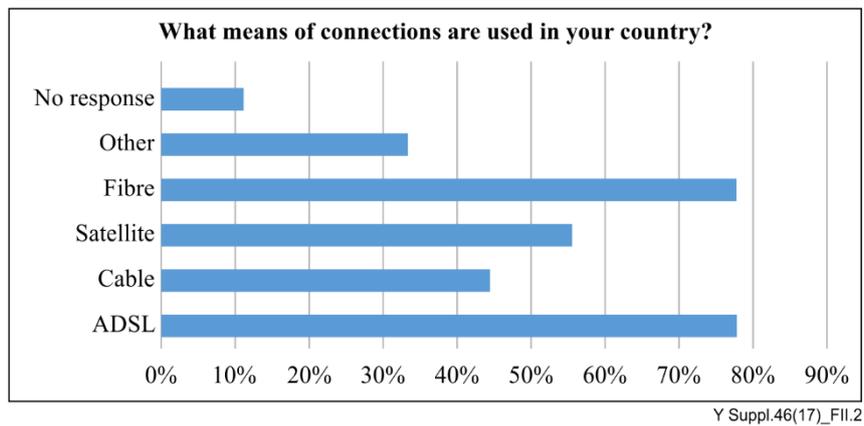
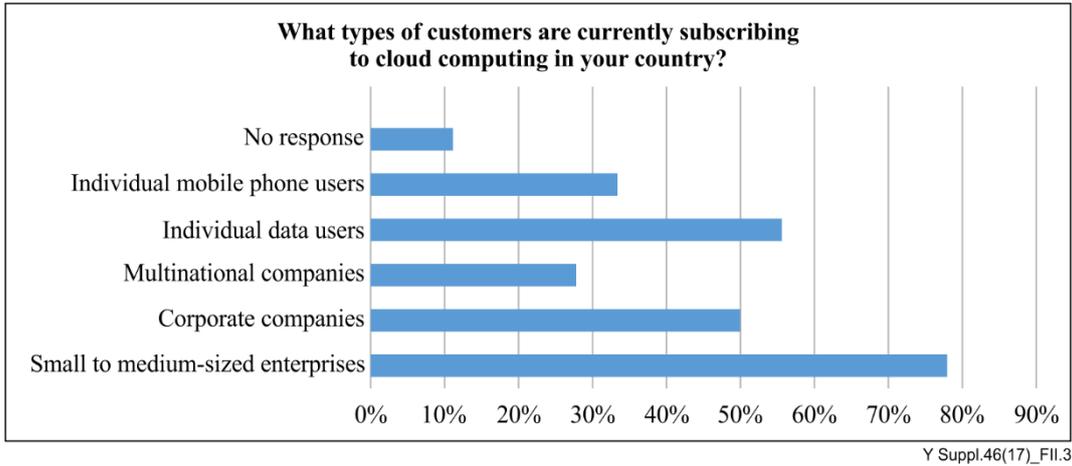


Figure II.2 – Network connectivity method

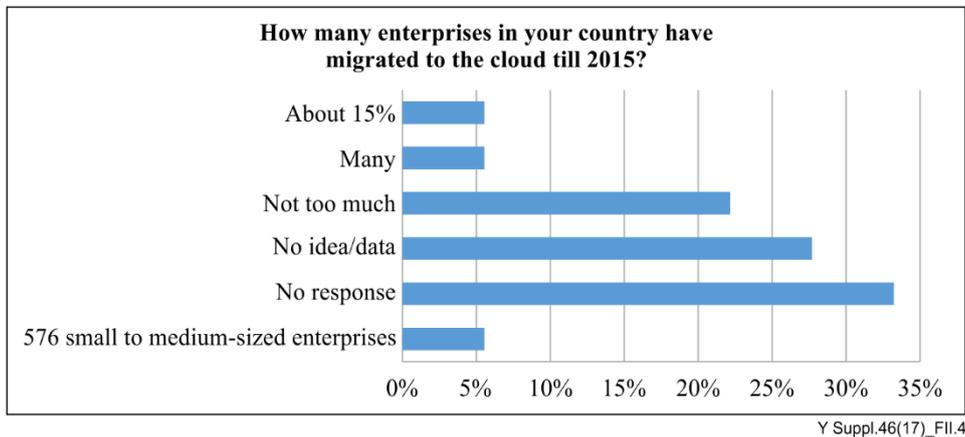
In addition to the provided options, responders mentioned "Wireless Radio Communication", "WIMAX", "Local network for the CDTA" and "Microwave" as means of connections used in their countries.

**1.3 What types of customers are currently subscribing to cloud computing in your country?**



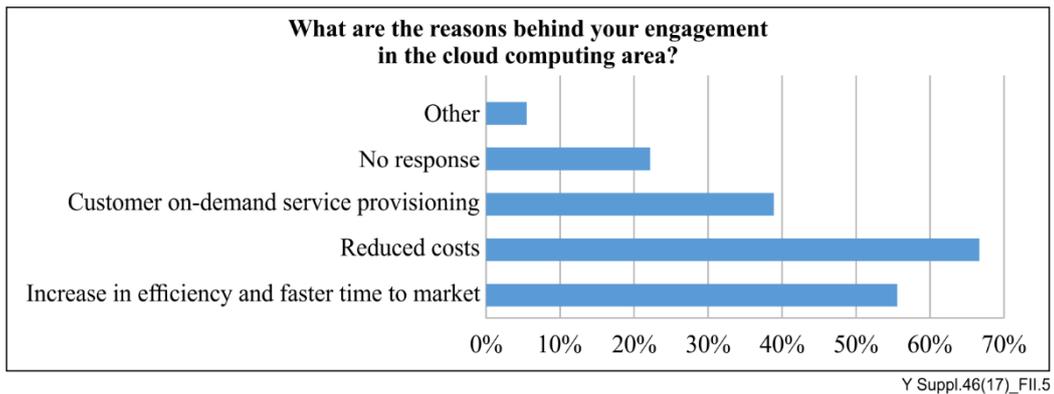
**Figure II.3 – Cloud computing customer segments**

**1.4 How many enterprises in your country have migrated to the cloud till 2015?**



**Figure II.4 – Cloud computing uptake**

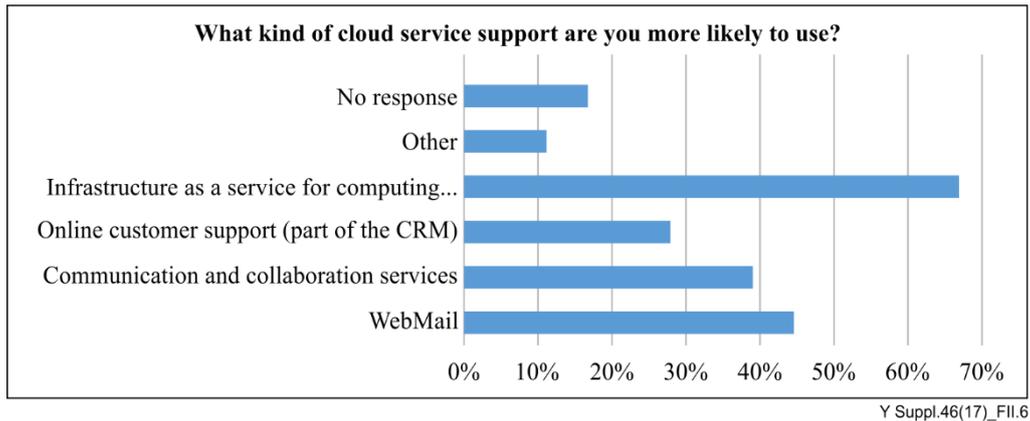
**1.5 What are the reasons behind your engagement in the cloud computing area?**



**Figure II.5 – Drivers for cloud computing service provision**

In addition to the proposed options, the developing of the sales of growth drivers was mentioned as a reason behind the engagement in the cloud computing area.

**1.6 What kind of cloud service support are you more likely to use?**



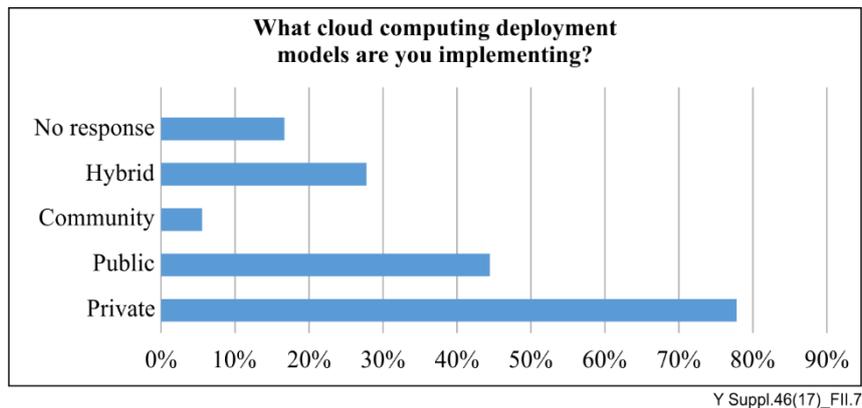
**Figure II.6 – Popular cloud computing services**

In addition to the proposed options, the following two responses were mentioned:

- SaaS business application (accounting, human resources management...) website management tool
- HPC for CDTA's researchers

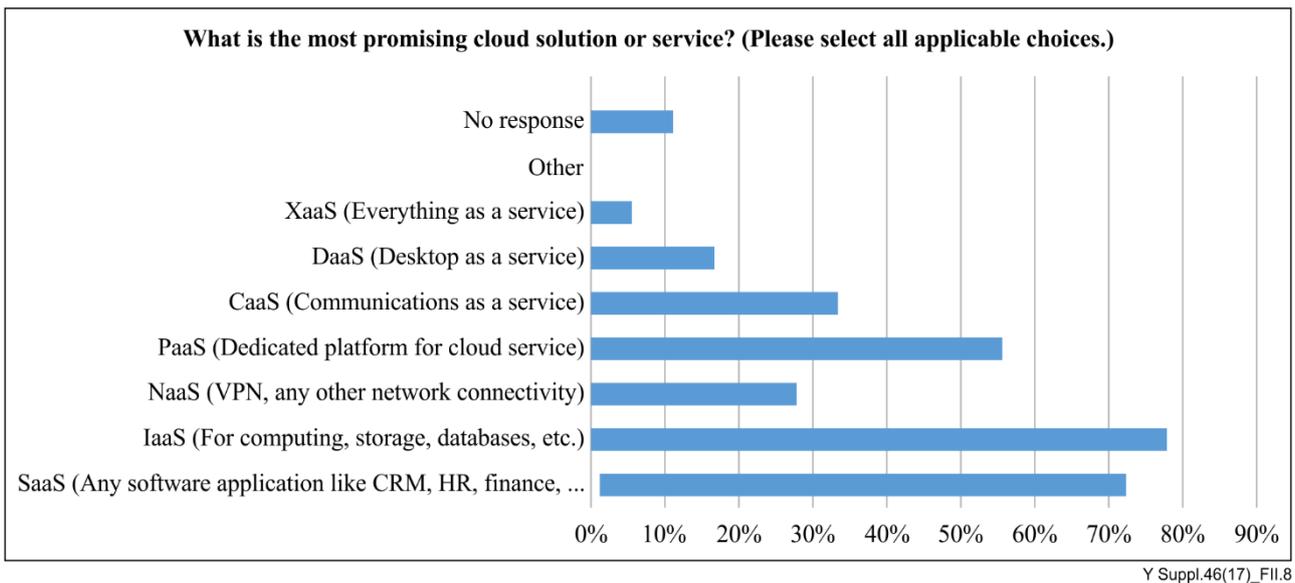
**2 Cloud computing deployment**

**2.1 What cloud computing deployment models are you implementing?**



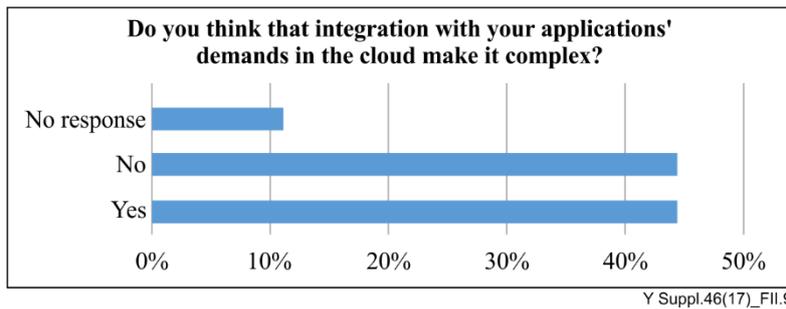
**Figure II.7 – Popular cloud computing models**

**2.2 What is the most promising cloud solution or service? (Please select all applicable choices)**



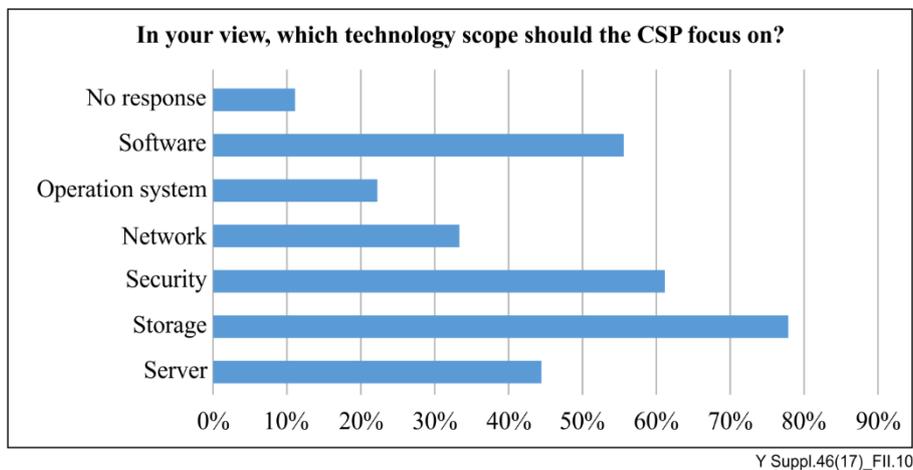
**Figure II.8 – Popular cloud computing services**

**2.3 Do you think that integration with your applications' demands in the cloud make it complex?**



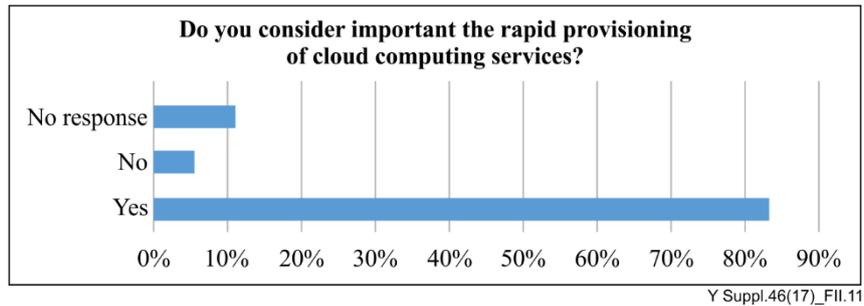
**Figure II.9 – Complexity of application demand**

**2.4 In your view, which technology scope should the CSP focus on?**



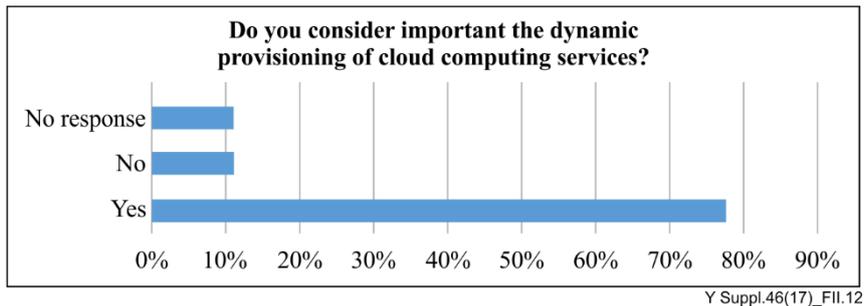
**Figure II.10 – CSP Focus Technology**

2.5 *Do you consider important the rapid provisioning of cloud computing services?*



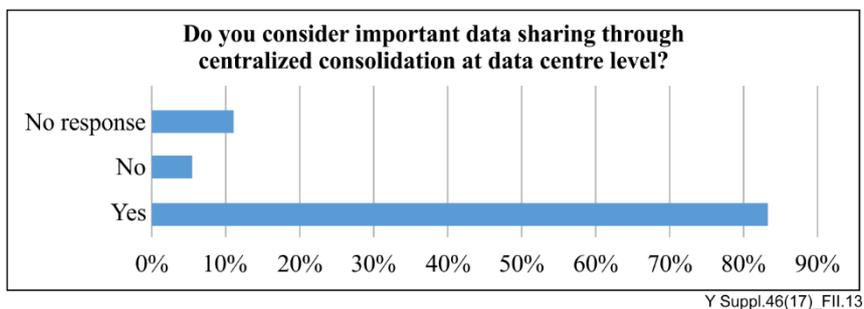
**Figure II.11 – Importance of rapid cloud service provisioning**

2.6 *Do you consider important the dynamic provisioning of cloud computing services?*



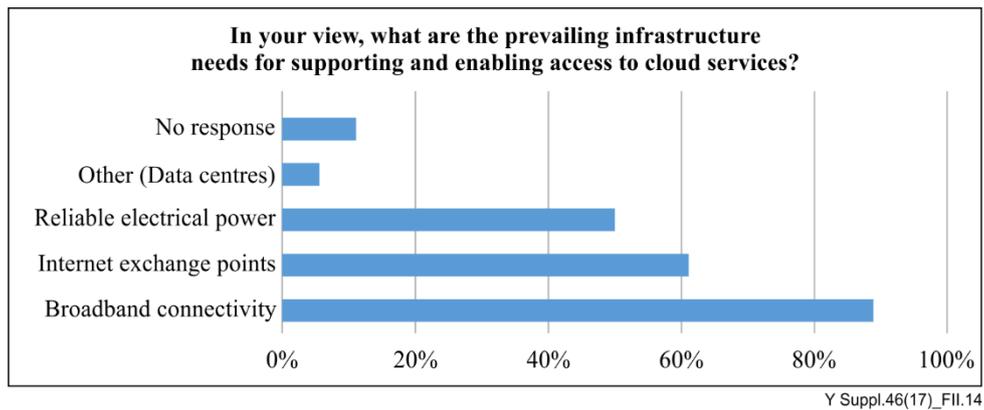
**Figure II.12 – Importance of dynamic cloud service provisioning**

2.7 *Do you consider important data sharing through centralized consolidation at data centre level?*



**Figure II.13 – Importance of data centre sharing**

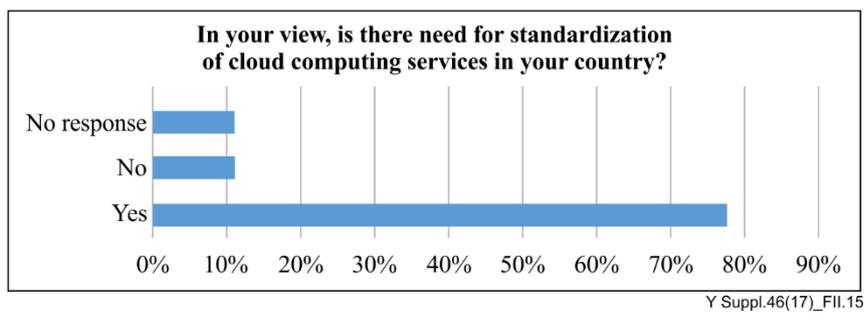
**2.8** *In your view, what are the prevailing infrastructure needs for supporting and enabling access to cloud services?*



**Figure II.14 – Infrastructure requirements**

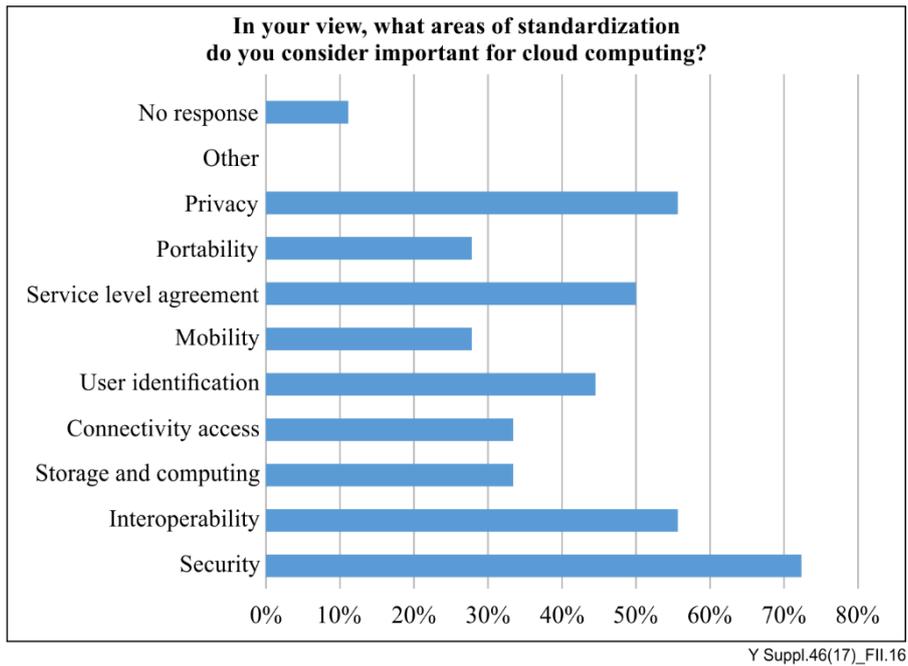
**3** **Standardization requirements**

**3.1** *In your view, is there need for standardization of cloud computing services in your country?*



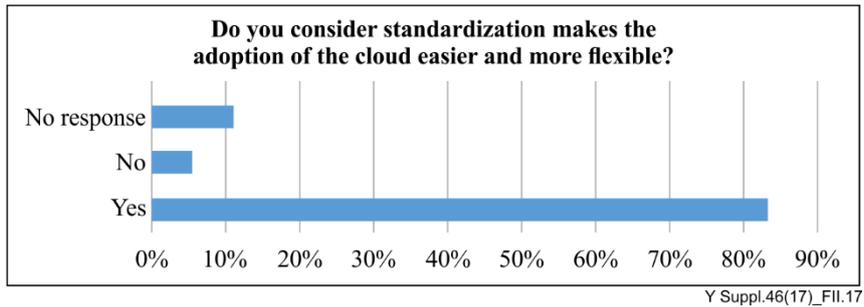
**Figure II.15 – Standardization requirements**

**3.2** *In your view, what areas of standardization do you consider important for cloud computing?*



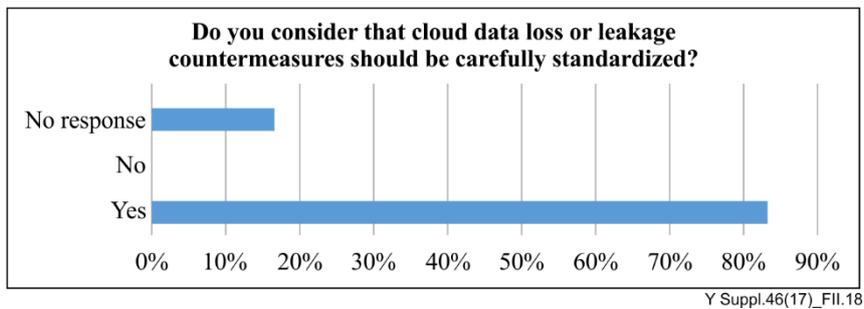
**Figure II.16 – Priority areas of standardization**

**3.3** *Do you think standardization makes the adoption of the cloud easier and more flexible?*



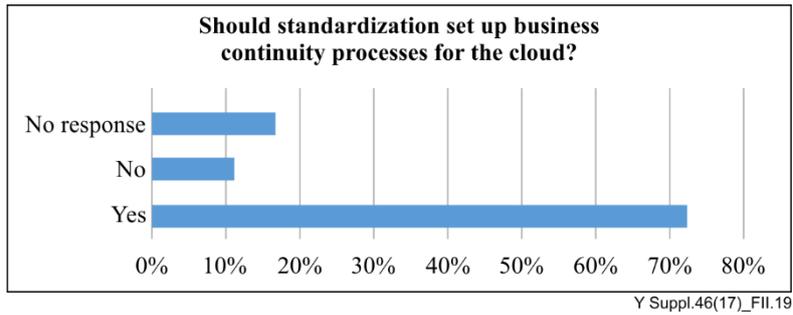
**Figure II.17 – Importance of standardization to cloud services uptake**

**3.4** *Do you consider that cloud data loss or leakage countermeasures should be carefully standardized?*



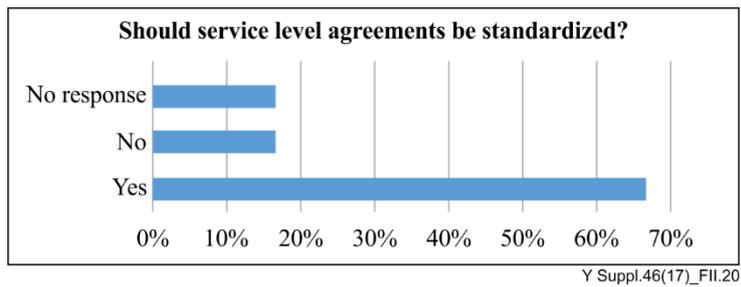
**Figure II.18 – Importance of data loss standardization**

3.5 *Should standardization set up business continuity processes for the cloud?*



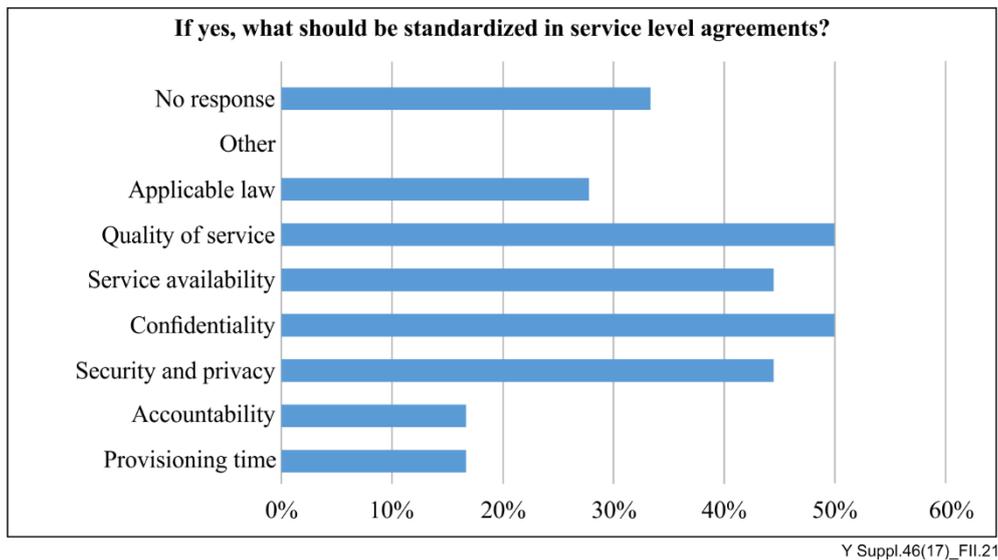
**Figure II.19 – Business continuity standards**

3.6 *Should service level agreements be standardized?*



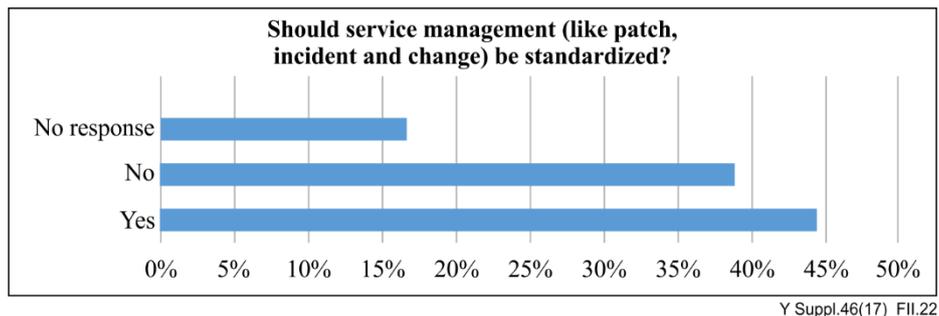
**Figure II.20 – SLA standardization**

3.7 *If yes, what should be standardized in service level agreements?*



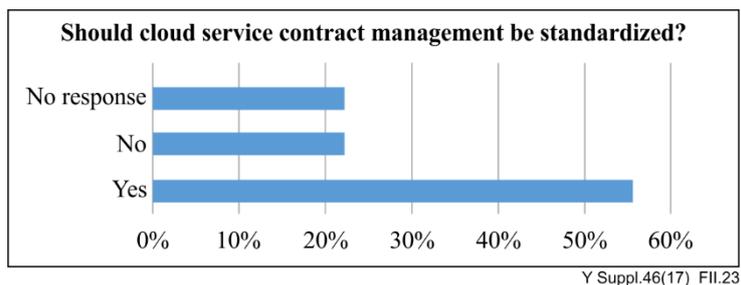
**Figure II.21 – Components of SLA standardization**

**3.8** *Should service management (like patch, incident and change) be standardized?*



**Figure II.22 – Service management standardization**

**3.9** *Should cloud service contract management be standardized?*



**Figure II.23 – Contract management standardization**

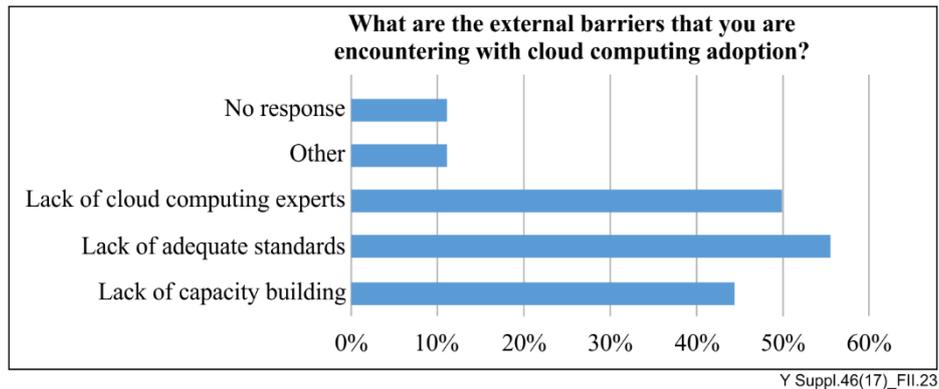
**3.10** *Can you identify some of the issues associated with cloud adoption that can be addressed with standards?*

Received responses are the following:

- Security
- Data lost
- Storage
- Quality of service
- Internet access connectivity standardization (bandwidth speed)
- Bandwidth price models regulation and infrastructure sharing
- Interoperability
- Availability
- Data privacy and localization of data (inside or outside the country)
- SLA
- Quality and confidentiality

## 4 Opportunities and challenges for cloud computing deployment

### 4.1 *What are the external barriers that you are encountering with cloud computing adoption?*

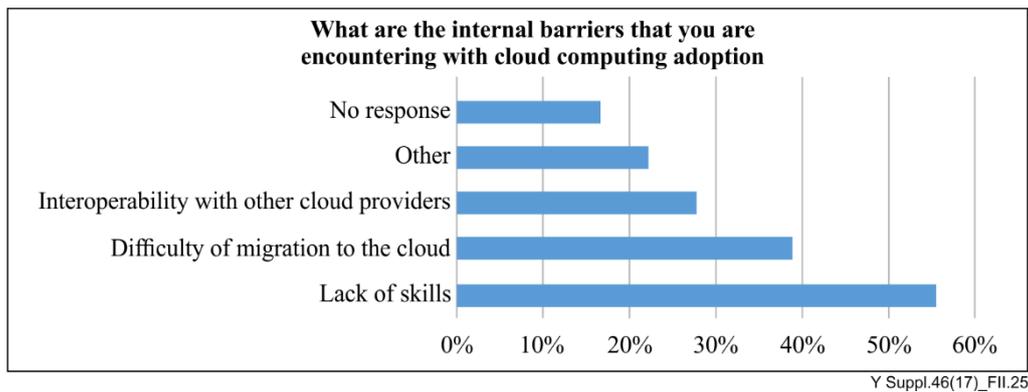


**Figure II.24 – External barriers to adoption of cloud computing**

The following two options were also mentioned by responders:

- the best international editor are not flexible for the adoption of their offer
- security concerns

### 4.2 *What are the internal barriers that you are encountering with cloud computing adoption?*

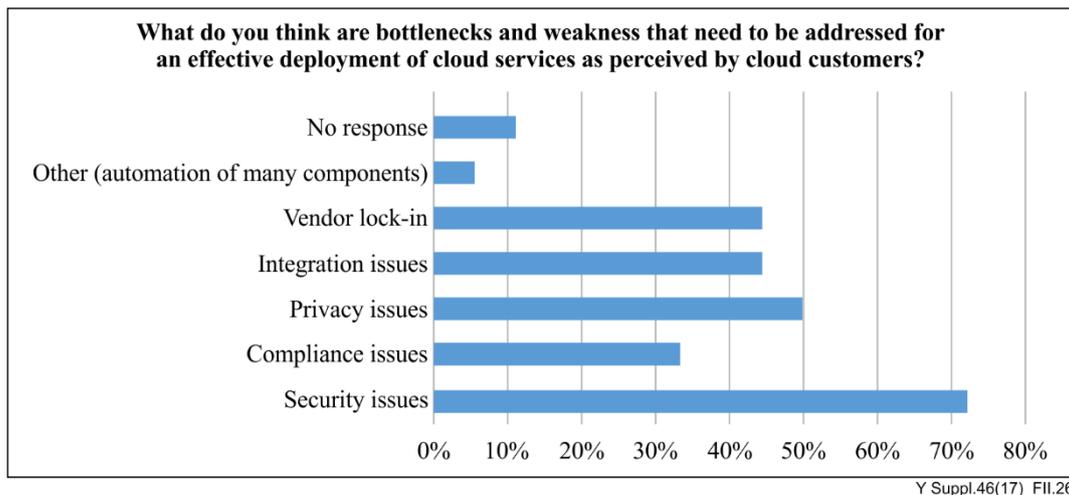


**Figure II.25 – Internal barriers to adoption of cloud computing**

Other options:

- Financing of infrastructure
- Lack of education in the benefits of cloud computing
- Lack of resources
- No need due to scale of operations

**4.3 What do you think are bottlenecks and weakness that need to be addressed for an effective deployment of cloud services as perceived by cloud customers?**



**Figure II.26 – Bottlenecks to adoption of cloud computing**

Automation of many components was also mentioned among bottlenecks that need to be addressed for an effective deployment of cloud services as perceived by cloud customers.

**4.4 What are the scenarios that can spur the adoption of cloud services in the country and in developing countries?**

Received responses are the following:

- Electricity supply, broadband connectivity, security and privacy issues
- Access to finances for CSPs, more capacity building and training for end users
- White labelled solutions
- Bandwidth cost
- Cloudification of infrastructures is not a matter of choice any more
- Government support and regulation, capacity and skilled manpower
- Providing cloud services by Telcos may increase the adoption of these services in the developing countries because Telcos are trusted parties in these countries
- Economies of scale (shared resources, cost savings, cost reduction)
- Centralised government services
- Local data centres for SME's
- Website hosting locally
- Cloud computing awareness workshops
- Developing countries are providing cloud services by telecom companies, but we do not have it by telecom company

## Bibliography

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