Analysing the development
of the broadband ecosystem in the Republic of the Congo 2014 – 2018

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Abstract

Broadband availability and access is a critical concern for the Republic of the Congo, as the acquisition of network infrastructures is of utmost importance for all countries aspiring to be competitive in an information-based economy, particularly developing countries. Broadband is an enabler of growth that has profitable synergistic effects in all sectors of life including health, education, banking and other economic sectors, government administration, and democracy. This study attempts to understand how policy and regulation affects the development of the broadband ecosystem in the Republic of the Congo. It considers ways in which policy and regulation may address the remaining gaps in broadband development.

The case study adopted a qualitative approach, whereby documents including law and regulation were reviewed, and semi-structured interviews were conducted with selected knowledgeable respondents. The analysis of findings indicates that the broadband ecosystem would develop and allow individuals to enjoy broadband, if appropriate actions are taken through policy, electronic communications sector law, regulation, management, and development of relevant skills for broadband services and use. Only then, will the country put itself on track and enter the knowledge and information society, for the benefit of the majority of citizens. Such appropriate actions include a particular focus on the national backbone project, the rehabilitation of the ADSL infrastructure for the last mile part of the broadband network or replacement of the ADSL infrastructure with more advanced wireless technologies, and addressing the management and governance concerns within the state telecoms company.

Declaration

I declare that the research report is my own, unaided work. It is submitted in partial fulfilment of the requirements of the degree of Master of Arts in the field of ICT Policy and Regulation (MA ICTPR) in the University of the Witwatersrand, Johannesburg. It has not been previously submitted for any degree or examination in any other University. Where the efforts of others and the sources have been used or quoted, they all have been acknowledged by means of complete references.

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Signature (Jean Philémon Kissangou) Date 15 November 2019

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Last and certainly not least, my mother, my brothers, sisters and relatives, all I sincerely acknowledge for your contribution and prayers.

Dedication

To my father Mouanda Jean, who is no longer of this world, and who from my early years taught mean attachment to God, and conveyed his humbleness and work values.

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Acronyms

ADSL	Asymmetric Digital Subscriber Line
ARPCE	Agence de Régulation des Postes et des Communications Électroniques
CAB	Central African Backbone
CDMA	Code Division Multiple Access
DGPT	Direction Générale des Postes et des Télécommunications
EDGE	Enhanced Data Global Evolution
FTH	Fibre to Home
GDP	Gross Domestic Product
ICT	Information Communication Technology
IMF	International Monetary Fund
ISP	Internet Service Provider
ITU	International Telecommunications Union
MPTEN	Ministry of Posts, Telecommunications and Digital Economy of the Republic of the Congo
NCP	National Coverage Project
OECD	Organization for Economic Co-operation and Development
PRCTG	Programme de Renforcement de Capacités et de Transparence Gouvernementale
SNE	Société Nationale d'Électricité
UNDP	United Nations Development Program
WACS	West African Consortium System/West African Cable System
WB	World Bank
XAF	local currency Congolese franc or FCFA

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Chapter One: Foundational assessment of the broadband ecosystem development in Republic of the Congo

1.1 Introduction

The purpose of this research is to study the development of the broadband ecosystem in Republic of the Congo. This case study was conducted to explore the extent to which policy and regulation addresses the development of broadband in Congo-Brazzaville. Broadband in this study refers to high-speed data transmission in which a single cable or wave medium can carry a large amount of data at once. Broadband policy is a vision a government sets to provide broadband infrastructures and services to a number of citizen in a given amount of time. Broadband regulation refers to the rules made by a regulatory authority to implement in order to achieve those outcomes set in the broadband policy. Policies concerning broadband include – national broadband policy and strategy, a national digital policy, competition policy to attract investment, universal access policy and strategy, taxation policy, spectrum policy and more. Unlike regulation, pertaining to broadband covers aspects such as pricing, spectrum regulation, infrastructure sharing, rights of way, quality of service regulation, and consumer protection.

The deployment of broadband, in a number of emerging countries has resulted in numerous socio-economic benefits including growth of per capita GDP, increased exports, and improvement to the quality of life of citizens. It is widely recognised that broadband assists in delivering the socio-economic benefits of information and communication technologies (ICT) to the public, resulting in alleviation of poverty and reducing social divisions in the society (Jameel, Ehsan, Mirza, & Bhatti, 2012).

Broadband has transversal benefits that affect all sectors of life. The benefits of broadband can reverberate throughout the economy, and act as essential input in various other sectors, including education, health, transportation, energy and finance; similar to the impact that electricity has had on productivity, growth and innovation (Kelly & Rossoto, 2012). Research shows that 20% increase in ICT investment can lift a country's GDP by one percentage point; making national broadband networks a matter of strategic concern to governments around the world (Broadband Commission, 2016). Therefore, public intervention (policy and/or funding) is necessary to meet future bandwidth needs and to ensure that society at large can reap the benefits of the digital economy (European Commission, 2015).

Republic of the Congo decided the adoption of broadband was the best way to boost its development for the benefit of its citizens. The process of roll out of broadband infrastructures in Republic of the Congo began in 2009 which resulted in the connection of the country to the undersea cable on May 12th 2012, considered as a crucial step in the development of broadband in the country.

Although Republic of the Congo is classified as a lower-middle-income economy (MFI, 2016), the country has experienced a relative prosperity as of 2010, mainly thanks to its oil resources. Notably though with the recent falling of barrel prices in 2014, the country now seeks new ways for socio-economic development. In many countries where governments are striving to develop broadband, policy makers and regulators have made the penetration of broadband services a main priority (Vincente & Gil-de-Bennabé, 2010). Likewise, Republic of the Congo needs to acclimatize to the development of broadband infrastructures and services.

Indeed, policy and regulation are paramount for the development of broadband. In order to achieve the potential of broadband, governments must institute effective policies that spur supply and demand, as well as encourage uptake of broadband in all sectors of the economy (Kelly & Rossotto, 2012). In the same way, Choi (2011) indicates that broadband networks are fundamental infrastructures in the area of information. As such, they have a significant impact on democracy, economy, and on society as a whole.

Regulation provides a predictable, legal framework within which businesses and citizens can act, plan and invest (OECD, 2002). Regulatory intervention is necessary to sustain competition on the downstream section of the network, including the last mile. As such, regulations should be set to allow competition in the wholesale and retail markets. Any regulator should continuously ensure that competition is promoted in the broadband market (Proenza, 2005). In the same vein, Paparissi and Zaks (2006) argue that without creative regulation that sparks market competition while combining state-related support of technology diffusion, broadband diffusion is stalled. It is important that the regulator be in the position to set a strong framework, which fosters competition and low prices, and extends the broadband network to rural areas. A stable and predictable regulatory framework is necessary to cultivate long-term investment in broadband infrastructure. Sound regulations can help infrastructure expansion by lowering the costs of deployment (OECD, 2016).

In the particular case of Republic of the Congo, it seems that policy and regulation falls behind the rollout of broadband creating a gap between the development of infrastructures and the policy formulation and regulation framework. The roll out of broadband infrastructure alone cannot create value in society (ITU, 2016a; 2016b). Broadband not only plays a critical role in the workings of the economy, it connects consumers, businesses, governments and facilitates social interaction (OECD, 2008). Recognizing the widening broadband divide and the risk of some groups missing the economic and social benefits of broadband access and use, policymakers in many countries are working to promote it (World Bank, 2010). In the case of Republic of the Congo, broadband should provide the way forward to improve the welfare of the majority of its citizens.

1.2 Research Problem Statement

Republic of the Congo has launched the development of broadband infrastructure and services. The country is connected to the undersea cable since 2012. Two broadband projects, namely the national backbone project (National Coverage Project, NCP) and the regional Central African Backbone (now in its fourth phase, CAB4 with respect to linking through Gabon, Cameroon and Equatorial Guinea) are still underway, since 2003 and 2009 respectively. The fact that these two projects were delayed in their completion leaves many citizens out of broadband development opportunities. It is unclear whether this bottleneck in the development of the broadband ecosystem is occurring due to the lack of policy for the broadband ecosystem, or due to the weakness in the regulation, or for other reasons. This is a gap in knowledge that this research report seeks to fill.

1.3 Research Purpose Statement

Given the premise that the development of a broadband ecosystem requires a number of elements that interact in a harmonious and efficient manner, the purpose of this study is to identify problems that underpin the development of the broadband ecosystem in Republic of the Congo and indicate ways forward to address these problems. To this end, this research will analyse the development of the broadband ecosystem in Republic of the Congo, in terms of broadband network implementation, including policy and regulation perspectives. The study intends to: (1) investigate the development of broadband in Republic of the Congo, (2) explore the current policy and regulation frameworks, and (3) arrive at recommendations, for a more stable and regulated broadband ecosystem in Republic of the Congo.

1.4 Research Questions

Based on the above, the following main research question were proposed:

How can policy and regulation address the challenges in the development of the broadband ecosystem in Republic of the Congo?

To address this question, three sub-questions are posed to give extra insight to the main research question.

Sub-questions
(1) How have policy and regulation affected the development of the broadband ecosystem in Republic of the Congo?

(2) What are the main challenges that hinder the development of the broadband ecosystem in Republic of the Congo in general and more specifically the national backbone project (the NCP)?

(3) What key policy and regulatory interventions are required for an effective development of the broadband ecosystem?

1.5 Background: Population and geography relevant to broadband diffusion

Republic of the Congo is a small, middle-income country located in the central Africa sub-region. Its geographic area is 342,000 km^2. The current population of Republic of the Congo is 5,542,197 as at 2018, based on the United Nations estimates, with 62% of the population living in urban areas (Worldometers, 2018). Seventy percent of the population live in the south-western part of the country, where the main cities and urban areas are located, including Brazzaville (1,8 million), Pointe-Noire (1,1 million), Dolisie (171, 773), Nkayi (73, 478) and Ouesso (37,102) (PopulationData.net, 2017).

As an oil exporter, the country's economy is heavily dependent on this production. The state derives 70% of its revenue from this sector, which accounts for 58% of GDP. However, this is not its only source of wealth. Congo also enjoys plentiful green resources: 65% of its territory is covered with natural vegetation (US Chamber of Commerce, 2017). The country has borders with five countries, namely Gabon, Angola, Cameroon, Central African Republic and Democratic Republic of Congo.

The Republic of the Congo has 169 km of coastline along the Atlantic Ocean between Gabon and Angola and has a deep-water international ship and port facility security (ISPFS) at Pointe-Noire, one of the certified ocean ports in the region see Figure 1.1 below, making Republic of the Congo eligible to exchange shipments directly with the United States. The country has a variable terrain with grasslands and forest in the north, a plateau in the centre and forest and mountains in the south. Congo has the largest rainforest in the world. It is bordered, on the East side, by the second-largest river in the world, -*le fleuve Congo*-.

Figure 1.1Map of the Republic of the Congo

Source: United Nations, 2017

To provide broadband to the majority of the population, namely the 2,4 million people living in the four main cities, requires that broadband infrastructures be built along those areas. To provide broadband to the remaining population of around 2,3 million people, spread sparsely throughout the country requires the extension of broadband using a wide range of technologies applicable to the particular geographical terrain, and to introduce appropriate policies for universal access to broadband, in order to include those disadvantaged populations in the digital economy.

The undersea cable is extended throughout the country by the main national terrestrial backbone (NCP, cable), which is laid along the South west areas from Pointe-Noire to Brazzaville. Between those two main towns there are nine landing points of which three are located in main centres Dolisie, Nkayi and Madingou (with populations between 60,000 and 90,000), and six in rural centres and villages including Hinda (32,995), Yamba (14,370), and Kinkala (34,608), according to the last public statistics (Government of the Republic of the Congo, 2017).

From Pointe-Noire to Dolisie, the terrain is a mountainous chain covered by dense equatorial forest which spreads out to Gabon and DRC. Another area covered by the forest in the country is the North East with a wet tropical forest along a non-mountainous terrain. The remaining areas are covered by plains, with a very flat

terrain in the centre of the country called the plateau Batéké. The nature of the terrain presents many challenges to broadband rollout, including cost and quality of access.

1.6 Economic background relevant to broadband diffusion

The Republic of the Congo economy is based on oil, which accounted for 55% of GDP in 2014, 80% of exports and 22% of government revenues (Lazard, 2016).

Table 1.8 Economic indicators: Republic of the Congo, 2011–2016 (including forecast)

	2011	2012	2013	2014	2015F	2016F
Population (Millions)	4.0	4.1	4.2	4.3	4.4	4.5
GDP per Capita (USD)	3,629	3,343	3,223	3,171	2,031	2,190
Nominal GDP (USD Billions)	14.4	13.7	13.5	13.6	8.9	9.8
Real GDP (%)	3.4	3.8	3.3	6.8	1.0	6.5
Year-end CPI (%)	1.8	7.5	2.1	0.5	1.8	2.2
Fiscal Balance (% of GDP)	16.5	6.4	-1.8	-7.7	-9.4	-2.6
Interest (% of Revenues)	0.4	0.4	0.6	0.5	0.7	0.7
FC Debt/Public Debt (%)	71.0	75.4	3.0	89.4	93.5	96.2
Government Debt (% of GDP)	33.1	34.1	38.2	41.8	57.5	54.1
Government Debt (% of Revenue)	77.8	80.1	81.4	98.8	139.6	126.2
Current Account (% of GDP)	6.0	-1.2	-3.4	-3.2	-11.6	-3.1
FDI (% of GDP)	21.1	16.4	18.9	20.3	25.1	23.5
External Debt (% of GDP)	23.5	25.7	32.0	36.4	48.5	44.3
Foreign Reserves/External Debt (%)	179.8	154.7	117.8	110.8	86.5	79.3
Foreign Reserves (Mo. of Imports)	9.0	8.0	7.4	9.3	6.5	5.9
Foreign Reserves (% of GDP)	42.3	39.7	37.7	40.3	42.0	35.2

Source: Lazard, 2016

Lazard (2016) claims that, as a result of its dependence on oil exports and the declining oil prices the world witnessed from 2014-2016, the fiscal deficit has deteriorated significantly, going from a surplus of 16% of GDP in 2010 to an expected deficit of 9.4% of GDP in 2016. By 2016, Republic of the Congo oil reserves had declined to the equivalent to 42% of GDP (Lazard, 2016). A vast majority of oil exploration activities and production in Congo comes from offshore fields, which many also contain associated gas. Although the country has sizable proven natural gas reserves, only small amounts are monetized due to the lack of gas infrastructure. "In the country, 17 percent (55 Bcf) the gas production was flared or vented. Due to the lack of gas infrastructure, only 41 Bcf of dry natural gas was domestically consumed" (Abarrelfull, 2015).

The capital Brazzaville and the capital Kinshasa (in the Democratic Republic of Congo), are the two closest capitals in the world, separated only by a river. This proximity represents significant business opportunity as the two countries could easily interconnect their respective broadband backbones and other facilities, thus further extending their corresponding ICT services markets.

According to the World Bank the contribution to the GDP of the different economic sectors is as follows: agriculture (4.9%), services (25.3%), and industry (69.8%), of which 66% derives from the petroleum sub-sector (World Bank, 2016). Oil is the stronghold of the economy as the Congolese Government banks heavily on the oil industry, which yields roughly 80 percent of its fiscal revenue, and represents approximately 70 percent of the Congo's gross domestic product (GDP) (The Times of Africa, 2016). As many countries Republic of the Congo has strong relationship with the International Monetary Fund (IMF). From December 5th to 20th 2017, the IMF sent a mission to Republic of the Congo to discuss the authorities' economic and financial program and possible financial support by the IMF. One of the findings was that "Congo's economy continues to suffer from the effects of low oil prices, unsustainable debt, and significant governance weaknesses. A deeper recession of the nonoil economy in 2017—with growth estimated at -9.2 percent—is hurting the most vulnerable segments of the population […] Weak anti-corruption bodies and poor statistics create enforcement gaps and heighten economic vulnerabilities" (IMF, 2017).

The GINI index (the measure of the degree of inequality in the distribution of income among individuals or households within a country) in Republic of the Congo was equal to 42.1 in 2016 (The World Bank, 2016). Furthermore, Congo's Human Development Index (HDI) was 0.592 in 2016, ranking the country 135 out of 188 in the world. Congo ranks 176th (out of 189 countries) in the World Bank's Doing Business Ranking 2017 Report, in comparison to its neighbour Gabon and to South Africa, which are respectively 164th and 72rd (World Bank, 2017a). In the Mo Ibrahim index ranking, which measures governance quality, Congo ranks at 43th over 53 in Africa (Mo Ibrahim Foundation, 2018). In March 2006, Republic of the Congo started with the Enhanced Heavily Indebted Poor Countries (HIPC) initiative with the World Bank and International Monetary Fund. As a result, the country benefited from a debt relief of USD 1.9 billion, equivalent to 32.4% reduction of Congo's sovereignty debt. The following table offers a snapshot of key indicators, for the 2015-2016 period, the early period of this study.

Table 1.9 International rankings: Republic of the Congo

Indicator	**Year**	**C-B world ranking**	**Number of countries ranked**	**First in Africa/ world ranking**
GDP per capita	2016	138	170	Gabon /67
ICT development index	2015	141	167	Mauritius /73
Mobile connectivity index	2015	104	134	Botswana /56
Cyber security index	2015	159	195	Egypt /30
Doing business	2015	176	189	Tanzania /49

Sources: World Bank 2016, ITU 2015, GSMA 2016

Republic of the Congo is a member of the Economic Community of Central African States (ECCAS), an organisation for the promotion of regional economic co-operation in Central Africa. With 10 member states, ECCAS covers an area of 6,630,539 km^2, and has a total population of approximately 121 million. The country is also a member of CEMAC, the economic community of Central Africa. The pace of growth of the CEMAC was low in 2015. It slowed to 1.6%, against 4.9% in 2014, due to reduced public investment and oil production (IMF, 2016).

Table 1.10 Congo GDP chart

	2014	2015(e)	2016(p)	2017(p)
Real GDP growth	6.0	1.2	4.2	4.7
Real GDP per capita growth	3.5	-1.4	1.6	2.1
CPI inflation	3.0	0.9	1.5	1.0
Budget balance % GDP	-4.8	-9.6	-1.8	1.3
Current account % GDP	-2.6	-14.5	-12.4	-9.6

Sources: Photius, 2016

In 2015, the country's growth slipped to 1.2%, from 6% in 2014, due to a sharp decrease in the world price of oil (60% of the country's gross domestic product [GDP]) and the result of slower expansion of the non-oil sector, (AfDB, 2016). The African Development Bank (AfDB) reported that Republic of the Congo's score on the UN Human Development Index improved slightly from 0.564 in 2013 to 0.592 in2016, which figures are still below other African states with at least the same income levels. Additionally, the AfDB (2016) claim "that poverty fell from 50.7% of the population in 2005 to 40.9% in 2011 but is still higher than average for middle-income countries. Unemployment is high, affecting in particular 30% of young people between the ages of 15 and 29, due to the capital-intensive nature of the oil sector and the weaknesses prevalent in the non-oil private sector". Much remains to be done in order for the country to begin to be recognized as an emergent economy.

1.7 Information Communication Technologies Ecosystem

1.7.1 Telecom market in the Republic of the Congo

The Congolese telecom market is mainly constituted of telecommunications mobile (GSM and recently 3G) services. The 3G-4G penetration is equal to 61% (ARPCE, 2018). The fixed phone market is small due to the weak provision of fixed lines by the monopoly state owned fixed operator, Congo telecom. The country has four mobile operators: Airtel (1998), MTN (2000), Warid and Azur (2010) with 49,95%, 53,15%, 5,89% and 0,01% of the market share respectively. There are nine (9) ISPs that share the Internet market. Although the new sector law has addressed convergence, different laws and different regulators affect the broadcasting and telecom/ICT sector.

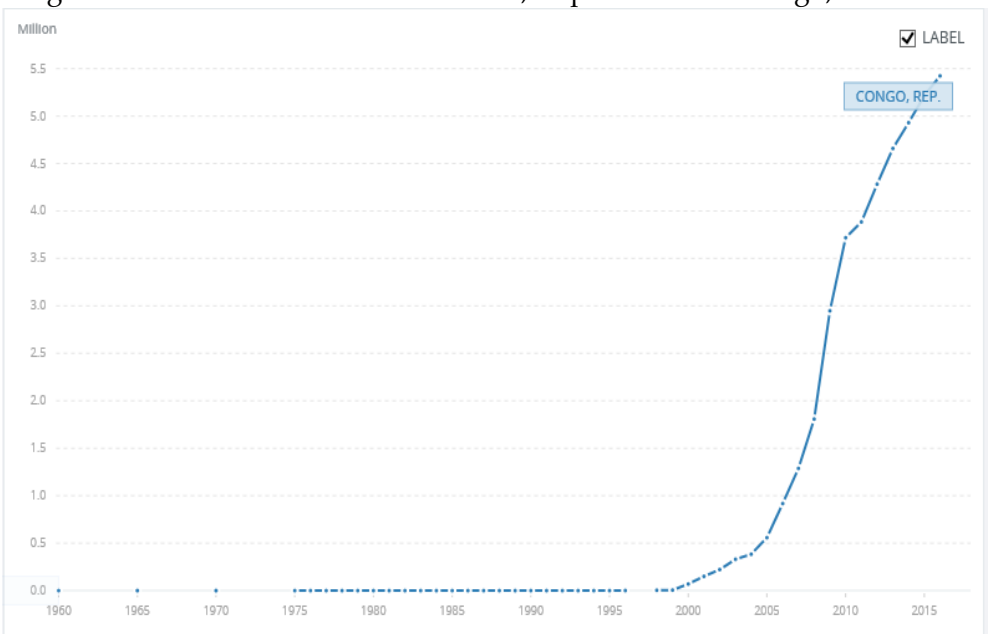
Table 1.11 Republic of the Congo's phone and Internet data

Year	Fixed telephone per 100 inhabitants	Mobile telephone per 100 inhabitants	International Internet bandwidth Bits/s per internet user	Percentage of households with computer	Percentage of households with Internet
2010	0.3	90.4	117	3.5	0.7
2014	0.4	108.1	185	4.9	1.9
2017	0.3	96.1	n/a	5.7	3.0

Source: ITU, 2015; ITU, 2018

In 2017, there were no fixed broadband subscriptions (per hundred inhabitants), there were 5.9 mobile broadband subscriptions (per hundred inhabitants), and there were 8.6% of Congolese individuals using the Internet (ITU, 2018). The graph in Figure 1.2 shows how the mobile market developed in Republic of the Congo, in terms of subscribers, up to 2016.

Figure 1.1 Mobile subscriber evolution, Republic of the Congo, 2000-2016



Source: ITU, 2017

In the Internet broadband market, the mobile operators had a total of 2,371 million subscribers at December 2017 for a cumulated monthly revenue of XAF3,475,156,754 (USD6,533,294,70 at current rate) (ARPCE, 2018).

In January 2015, the regulator set floor tariffs in order to limit the anti-competitive decrease in retail prices by dominant operators. The regulator claimed that "since floor tariffs have been set, the market improved significantly and the competition is

now running normally. The tariffs returned to normal following the floor pricing that reduced the practice of predatory pricing by some operators (ARPCE, 2016a).

1.7.2 The undersea cable system: WACS and CAB

The undersea cable is a submerged underwater cable that connects different land-based stations for carrying telecommunication traffic across vast stretches of ocean. Republic of the Congo is connected to the undersea cable, which belongs to the WACS consortium of which the public telecom operators of countries are members. The WACS undersea cable landed at Matombi, a small village near Pointe-Noire in the south of the country. Thus, the landing station is located at Matombi, and connects to the terminal station located in Pointe-Noire through a high-speed line backhaul. Pushak and Briceño-Garmendia (2011) summarize the early status of the ICT infrastructure in their report by claiming the following:

> In the ICT sector, the Republic of Congo has made good progress in developing its mobile telephone market in recent years, with high levels of signal coverage. The cost of international connectivity is currently high, but it should fall once the country connects to the international submarine cable and completes its domestic fibre optic network. On the other hand, the physically dilapidated and financially depleted condition of the fixed-line telephone operator is becoming a constraint to raising Internet penetration.

As soon as the connection to the undersea cable was in place, the central African backbone and the national backbone became bottlenecks of the broadband infrastructure in the county. The fixed broadband infrastructure is a real problem in Republic of the Congo. In addition, the domestic fibre network is not completed yet, amidst doubts on its efficiency and the expressed distrust of Congo telecom, which is in charge of the fixed telephone infrastructure project. The roll out of the domestic backbone remains a big concern, as the national backbone will serve as the bridge between internal networks and the world.

The last mile is currently served through the mobile market by various wireless broadband technologies, thus the development of fixed infrastructure mainly through ADSL technology would be significant in the Congolese broadband infrastructure. The different last mile networks must be updated in terms of technology, so that broadband can reach everyone including those who live in the remotest of areas.

1.7.3 Broadband in Republic of the Congo: Dynamics, stakes and expectations

There exist many definitions of 'broadband' varying from country to country. Broadband is accepted as a continuous 'always on', high speed, Internet connection. Organizations like ITU, OECD, and the Broadband Commission specify the

minimum download speed ranges of a broadband connection ranging from 128 Kbps to 2 Mbps or higher, and avoid to set fixed figure on the desired maximum speed.

Congo has a history of broadband implementation for more than a decade. In 2006, the government set the National Coverage Project (PCN). The same year, the country signed an agreement with the World Bank to build a regional backbone to connect the five countries of the Central Africa region. Another component of the agreement was the installation of Internet exchange points (IXPs). In 2011, two broadband networks were built: the SNE (the national power company), providing the backbone that connects Pointe-Noire to Brazzaville along with the high-power electric lines; and the PRCTG, which connects financial administration offices in Brazzaville. Currently, with three completed and five ongoing broadband network projects, Republic of the Congo has been practically focusing on the development of broadband.

Today, the country has four completed broadband projects, with an additional 5th ongoing, which are presented in Tables 1.5 and 1.6 respectively.

Table 1.12 Broadband networks

	Network	Medium	Owner
1	Congo-Telecom	Fibre	The state owned Congo telecom
2	MTN-Backbone	Fibre +3G-4G	MTN
3	CAB	Fibre optic	Government of Republic of the Congo
4	3 G-MTN	Wireless	MTN
5	3 G-Airtel	Wireless	Airtel

Source: Researcher's customized data, 2018

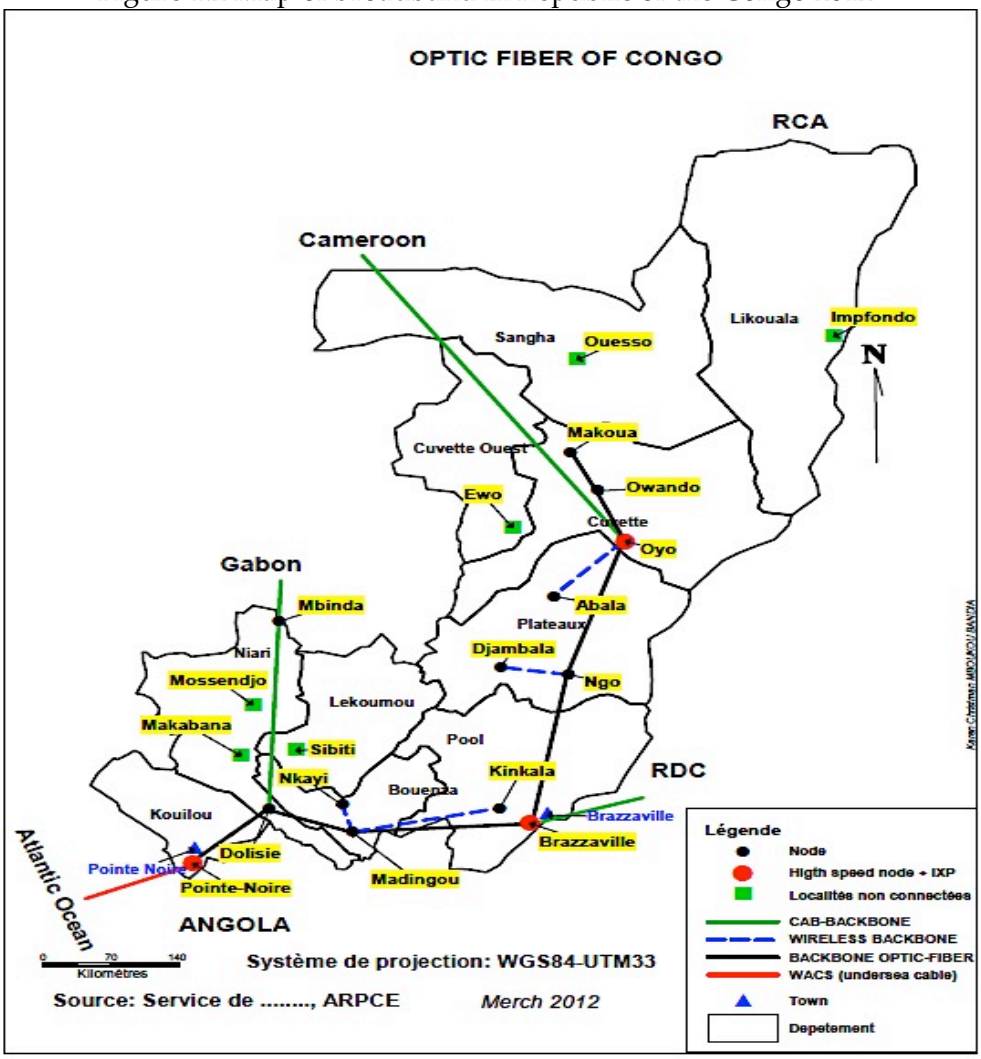
In 2018, the broadband network and services have been significantly extending across the country, and broadband networks are operational.

Table 1.13 Broadband networks underway in Republic of the Congo

Project	Segment	Investor	Beneficiary	Term	Cost (USD million)
CAB	Sub-regional	World Bank	Government	2018	116
NCP	National	Government	Congo telecom	NA	470

Source: Researcher's customized data, 2018

Figure 1.2 Map of broadband in Republic of the Congo 2012



Source: Researcher's customized data, 2012

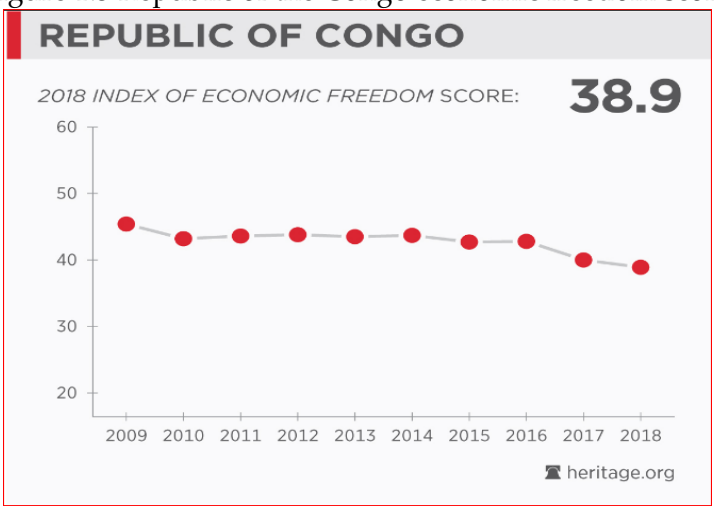
This map illustrates the presence of both wire (black lines)and wireless (blue dashes) broadband backbones. The green lines represent the CAB-backbone which will connect Republic of the Congo with Gabon, Cameroon and DRC. While the red line represents the undersea cable, the red points constitute the HUBs for the PCN projects, where an Internet exchange point is also to be implemented. The development of the broadband ecosystem in Republic of the Congo signals the roll out of broadband infrastructures, but requires the development in policy and regulation for its implementation.

The supply of the broadband network, however, was not matched by the demand. The value of broadband for a country is as infrastructure capital. Broadband is necessary to boost job creation and economic growth and to enhance regional and global competitiveness (Czernich, Falck, Kretschmer&Woessman, 2009; Atif, Endres & McDonald, 2012; ITU, 2012a; European Commission, 2015; Broadband Commission, 2016). As such, the services sectors, which now contribute to the

Republic of the Congo economy at only 16% on the GDP, would increase thanks to the new services generated by the use of broadband. Broadband can then promote innovative services such as e-government, which has an incremental growth effect to improve the delivery of public services to citizens and finally improve their quality of life. Currently, broadband networks are only used to deliver voice and to some extent Internet services. Unfortunately, none of the e-services such as ecommerce, e-health, e-education, e-agriculture, or e-employment are run through the broadband networks, which prevent users from fully benefitting from the potential of ICTs.

Economic opportunity and freedom are paramount for the development of broadband and ICT in general, noting the Republic of Congo economic freedom score at a low 38.9.

Figure 1.3 Republic of the Congo economic freedom score



Source: Heritage, 2018

Affordability of the broadband services was largely affected by the civil unrest and low level of economic development in the central African region. The Republic of the Congo per capita income has declined over several decades and telecoms/ICT infrastructures were destroyed during the civil wars, while education, health and governance were negatively affected at the expense of the population. Seventy percent of the population lives below the poverty line, and unemployment affects 50 percent of the active population, particularly youth. Currently the country is seeking new ways for the strengthening of its various economies. Due to an excessive dependence on oil revenues, the economic trend of the country remains fragile. Furthermore, shortcomings in the education, health and technology sectors constitute huge obstacles in the areas of economic and social development. Nevertheless, the Congo government has an opportunity to invest in broadband based services, thereby strengthening other sectors such as education, health, agriculture, and trade, job creation, and governance.

1.7.4 Consumer broadband market in Republic of the Congo

In Republic of the Congo the broadband consumer market is in its infancy phase. This market constitutes the wholesale market (though the backbones), and the retail market. The country does not have a definition of broadband. However, by habit in the country, broadband refers to a communication bandwidth of at least 128 Kbit/s. Since May 2012, the country is connected to the undersea cable though the WACS project. At one time, the country had used VSAT technologies to connect to the world. Those VSAT are still in use today in parallel with underway fibre technologies; with each mobile operator using its own domestic backbone, to connect their equipment throughout the country. As well operators commercialize broadband capacities to structures such us banks and ISPs.

The country uses CDMA, WiMax, 3G, and FTTH technologies for the last mile part of the network. These technologies help to connect customers to backbones. The ADSL network has suffered destruction due to the demolition of the fixed operator infrastructures' that occurred during the civil wars. The FTTH, a technology intended to bring fibre connection to homes, is not yet deployed by Congo telecom.

Table 1.14 Internet technologies used by operators in Republic of the Congo

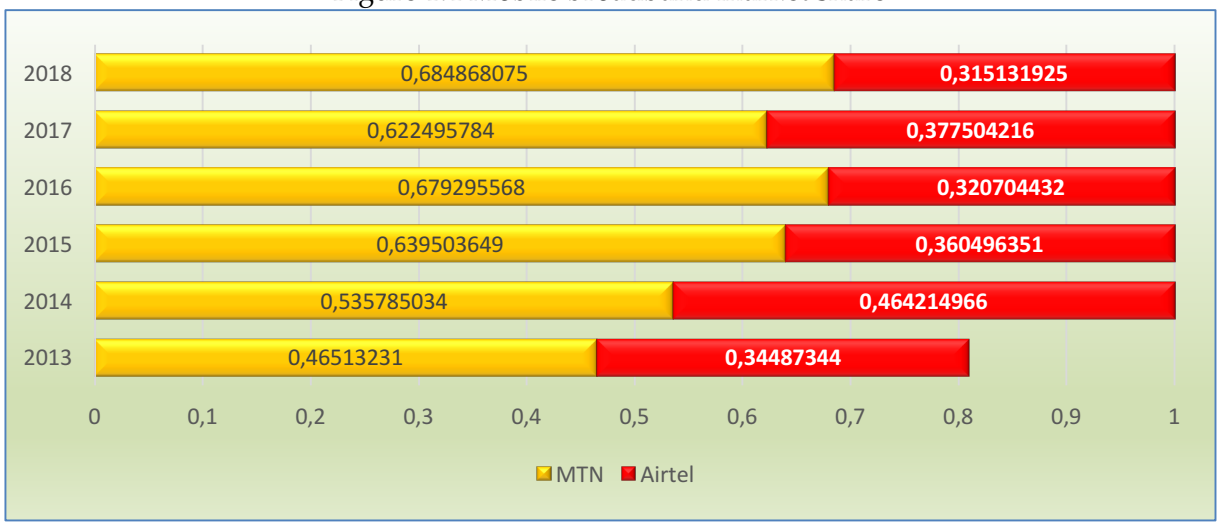
Operator	**CDMA**	**WiMax**	**3/4G**	**ADSL**	**FTTH**
Congo telecom	X			-	X
MTN		X	X		
Airtel		X	X		
All ISPs		X			X

Source: Researcher, 2018

While Congo telecom and MTN own the backbone facilities (wholesale market), they compete with other companies (mainly IPSs), which need those facilities to provide services in the retail market. In the absence of strong regulation, the dominant operators like Congo Telecom and MTN could set prices and restrict operators in the retail market. The broadband mobile market share is divided as follows: Congo-telecoms (35%) followed by MTN (28%) and then by Airtel (14%). The remaining three ISPs share 14% of the retail broadband market (ARPCE, 2015), see Figure 1.5.

With the arrival of mobile operators in the Republic of Congo telecommunications market, the number of ISPs decreased from 14 in 2015 to only three in 2019 (AMC , GVA and RURA) (ARPCE, 2019). This occurred, because of the introduction of 3/4G technologies, based on the needs of users of new services and innovative applications offered by the broadband market.

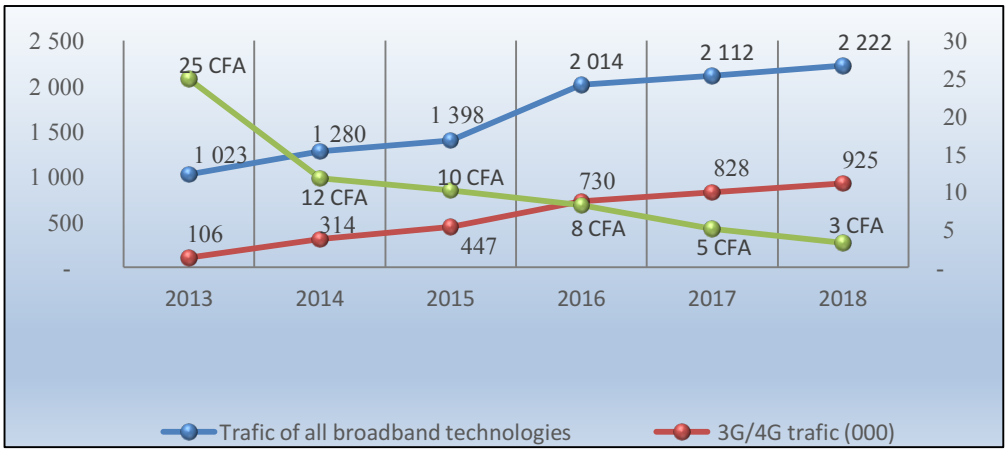
Figure 1.4 Mobile broadband market share



Source: ARPCE, 2019

Broadband data on mobile operators is available, except for Congo telecom. The two main mobile operators, MTN and Airtel, share the mobile broadband market. The above figure shows the broadband market share between 2013 and 2018.

Figure 1.6 Evolution of 3G/4G subscribers and tariffs



Source: ARPCE, 2019

In addition to the 3/4G broadband traffic, other data traffic comes from other broadband technologies such as WiMax and FTTH technologies. The global traffic grew from 1,023 million subscribers in 2013 to 2,222 million in 2018, while the tariffs decrease from 25 CFA (USD 0.04) the Megabit to 3 CFA (USD 0.01) in the same period (ARPCE, 2019).

Before discussing the broadband consumer market further, it is important to remember that broadband infrastructure has 3 three components: international

backbone (also known as T1 component), the national backbone (including the backhaul (T2)) and the last mile (T3) at the downstream part of the network. On the last mile portion, consumers have access either though their mobile phones, or through antennas placed on the roof or, to some extent, through copper cable, and to a lesser extent by fibre optics. The access network is the bottleneck of the broadband infrastructure in Republic of the Congo, noting that the National Coverage Project (NCP) monitors the access network. NCP began in 2005, and 13 years later, the project remains uncompleted, due to structural, technical and management challenges within Congo telecom (the company in charge of the project).

The number of subscribers started increasing in 2008, when Congo telecom launched the ADSL service. Due to short financing in the project, added with lack of skills and mismanagement, the number of subscribers for fixed broadband did not increase as expected. In terms of bandwidth, Congo telecom was able to provide only ranges from 64 to 512 Kbit/s.

1.7.5 Brief note on policy and regulation to promote broadband access and usage

The UNDP assisted the country to set its first strategic policy of 2007 the Congolese e-strategy, but the document has never been published, as the issued policy document did not meet standards for a "good policy" formulation that include among others objectives, timeframe, KIPs etc. In the same vein, the World Bank, which in 2009 has aided the country to set the ICT sector law, did not advise the country on how to formulate policy. The world Bank should has drawn the attention of the country on for it to take into account the 'wave of broadband' as the government was already engaged in negotiations to connect the country to the undersea cable. Despite, the elaboration of policy and regulation for spectrum is another issue, which needs to be considered when it comes to broadband. Indeed, wireless broadband components need spectrum. The digital dividend, mainly the future use of the 800 and 2600 MHz bands for LTE-4G technologies, will be a new way forward for broadband projects.

In 2004 and later in 2007, the UNDP assisted the country to set the Congolese e-strategy, but the document has never been published, as the issued policy document did not meet standards for a "good policy" formulation. The text was badly designed and deemed unworkable, consisting insubstantially of a list of projects and a budget, but no clear policy direction. On the other hand, the World Bank, which in 2009 aided the country to set the ICT sector law, did not advise the country how to formulate policy before setting the law. For example, a universal service is requested in the sector law while standards request the opposite. The elaboration of policy and regulation for spectrum is another issue, which needs to be considered when it comes to broadband. Indeed, wireless broadband components need spectrum. The digital dividend, mainly the future use of the 800 and 2600 MHz bands for LTE-4G technologies, will be a new way forward for broadband projects.

A lack of political will, and limited awareness of the importance of ICT in the development of a country across government departments, have played against the development of policy and regulation in the ICT sector in Republic of the Congo. The Electronic Communications Act (2009) does not include relevant issues such as broadband, leaving the regulator within a vacuum thereby preventing it from finding grounds to regulate the broadband industry.

The regulator has taken a few actions. In Republic of the Congo, data regarding 2G mobile penetration is not available. In February 2018, MTN disconnected around 30 localities where the company does not make money, but the regulator requested the company to reconnect those localities (ARPCE, 2018). In this way, at least a majority of householders have access to 2G mobile services in urban areas.

The absence of a clear policy and weaknesses in the legislation and regulation on the issue of broadband hinders the future development of the broadband ecosystem. Until March 2018, only Brazzaville and Pointe-Noire have fixed phone systems, used mainly for companies and administrations. In the remaining cities and in rural areas the fixed phone infrastructures have yet to be restored following the civil war, which then prevents a large part of the country from having a fixed phoned or fixed broadband connection. The 3G mobile broadband technology is available to a minor degree in varying small areas in the country. However, for affordability, skills and interest reasons only people who live in Brazzaville and Pointe-Noire use the 3G mobile broadband networks.

Since the beginning of 2018, no particular broadband user services are developed in the country thereby restricting people to any opportunities for broadband access. The majority of people using the mobile broadband do so mainly to connect to the Internet for classic services (browsing, e-mails, and social media services). Similarly, companies and businesses use broadband to connect to the Internet. Some businesses, in particular the banks, use broadband to connect to their respective remote branches across the country. Since e-government, e-business and more generally e-applications and services are non-existent in Republic of the Congo; these can be seen as big challenges to overcome at this time, especially with the roll out of the broadband ecosystem underway, creating potential access, but challenges for usage.

The Alliance for Affordable Internet (A4AI), an organisation which aims to make Internet affordable to people around the word, ranks a set number of countries each year since 2013. After seven years of this activity, the Republic of the Congo has not been included in any of these studies. The researcher tried to contact the A4AI but without success. It may be that the lack of cooperation in the data collection process, between the country and the organisation, is the main reason for lack of reporting. In

the A4AI 2018 report, the top five African countries are: Mauritius, Morocco, Nigeria, South Africa and Ghana.

1.8 Chapter summary

As a main topic of this case study, the status of the development of broadband in the country came into prominence. The development of ICT infrastructure is underway since 2003, but policy and regulation is lagging behind the rollout of broadband, the main issue to be investigated further in this piece of work. While the WACS project that connects the country to the undersea cable is a relative success, the CAB and CPN projects are not moving ahead as they are supposed to. As a consequence of the lack of proper national backbone, the lack of well-designed broadband policy and the weakness in regulation, the country is experiencing a bottleneck which prevents the broadband ecosystem to properly develop in the country.

Chapter Two: The importance of policy and regulation to broadband rollout

This chapter presents a review on the literature published on broadband related issues, particularly on policy and regulation. The literature review is a systematic way of finding, considering, guiding and synthesizing the research findings previously published on the specific topic of broadband. A literature review is both a summary and explanation of the complete and current state of knowledge on a particular topic as found in academic books and journal articles (University of Guelph, 2004). The purpose of a literature review is to objectively report the current knowledge, to provide the reader with a comprehensive overview, and place that information into perspective (Green, Johnson & Adams, 2006). The background data presented by the researcher in Chapter 1 led to the understanding of the importance of policy and regulation in the broadband development process. In addition, the literature review will guide the researcher in identifying key themes in the data.

This literature review will briefly describe ten themes: (1) broadband policy and regulation, (2)broadband and socio-economic development, (3) the role of undersea cable or international connections in the broadband value chain, (4) interconnection and broadband infrastructure sharing, (5) broadband spectrum and digital migration, (6) market structure, (7) universal access and service for broadband, (8) public-private partnership management model for broadband, (9) local content and (10) consumer protection. As the foundation for data collection, though only those themes where relevant data is available will be addressed in Chapter 4.

In this report, information and communication technologies refers to technologies that provide access to information through telecommunications infrastructures. It includes the Internet, wireless networks, mobile communications networks, and other communication media (Tech Terms, 2010). The Broadband Commission for Digital Development (2014, p.92) defines broadband as "a network infrastructure capable of reliably delivering diverse convergent services through high-capacity access over a mix of technologies". Broadband refers to the capacity for high-speed data transmission in which a single cable can carry a large amount of data at once and can carry signals from multiple independent network carriers. The broadband ecosystem can be defined as the complex relationship that occurs among components in the development of broadband services, from the infrastructure point of view and from the socio-economic value it adds. The broadband ecosystem is represented here in the form of successive inter-dependent layers: (1) infrastructure, (2) applications and services, and (3) policy and regulation.

2.1 Broadband policy and regulation

Policy and regulation are instruments governments use to enhance public interest outcomes, which would otherwise not occur. In this regard, policy sets guidelines or directives for these outcomes to happen for the benefit of citizens. Government sets

policies for all sectors of the society (education, commerce, health, environment, telecommunications etc.). Policy refers to a course or a principle set of actions that adopted or proposed by a government to guide decisions or a statement of intent (Eisner, Worsham, & Ringquist, 2006). Once a policy is adopted, relevant parts can be transformed into legislation, which would be passed by the Congress in the Republic of the Congo.

Regulation aims at implementing policy in practice in order to achieve those outcomes set in policy. It acts as a series of guidelines from the devising agency to help implement and interpret laws, with the goal of setting adhering rules and procedures. The classic approach to regulation is for states to intervene by prescribing a policy, which clearly indicates allowed and forbidden behaviour (Führ & Bizer, 2005), from which flows regulations that need to be put in place to assure smooth development of the broadband ecosystem. These regulations include attention to market structure and competition, pricing, spectrum matters, infrastructure sharing, technical standards, and consumer rights.

In the telecommunications and ICT sector, policies are usually set either for an entire sector or for different fields such as for universal access, digital migration, or broadband. Regulators have the duty to implement policies through effective regulation of markets for telecoms/ICT operators, who offer ICT services to consumers. Policy and regulation are paramount in the development of broadband, mainly because regulation provides a predictable, legal framework within which businesses and citizens can act, plan and invest (OECD, 2002). Melody (2001) sees regulation as providing a foundation for markets to perform well, and argues that, regulation is in fact a necessary function that guards against otherwise ineffective market performance.

Broadband has big socio-economic potential. However, in order for socio-economic development to occur, governments must institute effective policies that will spur supply and demand and encourage uptake of broadband in all sectors of the economy (Kelly & Rossotto, 2012). Many countries that make explorations in broadband development have developed policies on the subject. In Korea, for example, to succeed in broadband development, a number of policy steps have been taken by the government, including several plans for public investment in broadband, initiatives to expand demand for broadband services and policies to promote universal access to broadband. As such, "given these very comprehensive policies in place, it is natural to think that government's initiatives actually played a very effective role in generating the explosion of broadband services in Korea" (Izumi, 2002). In 2017, Iceland tops the International Telecommunications Union Information Technology Development Index (IDI) rankings. In 2016, South Korea had been ranked first three consecutive times in the ITU's *Measuring the Information Society* reports. The leadership of South Korea in this regard is in part because the

country has taken important policy steps for broadband adoption. In the same vein, "the dramatic growth of the broadband market in South Korea is the culmination of appropriate government policy, growing demand and market competition based on responsive supply" (Menon, 2011). Vincent and Gil-de-Bernabé (2010) agree with this view as they argue that other nations are ahead in terms of broadband, such as the Netherlands and Denmark, who have launched early national strategies to foster broadband. The development of broadband must be supported by strong strategies and legislation.

The development of broadband should not be separate from the regulation of the telecom/ICT sector. Indeed, the regulatory framework of telecommunications is one of the major factors that can have direct effect on broadband growth. In the case where the regulatory framework is insufficient, the telecommunications sector may malfunction (Bouras, Giannaka &Thrasyvoulos, 2009), and lead to the market failure. Frieden (2005, p.9) discusses the impact of market failure on investments and competition when he argues that:

> The combination of market downturn, legislative failure and lack of consensus on operating standards has removed many of the incentives for risk taking and investment, even as the need for network upgrades proved essential for the evolution of high-speed broadband ICT services. Stakeholders appeared more intent on competing in the courtroom than in the marketplace.

As technologies develop, regulation must follow to adapt new configurations. Ferguson (2006) wrote on the matter, in connection with the divestiture of AT&T that "regulatory changes permitted new entrants to join the market". In the same way Papacharissi and Zaks (2006) argue that without creative regulation that sparks market competition while combining state-related support of technology diffusion, broadband diffusion is stalled. Choi (2011) indicates that as a fundamental infrastructure in the era of information, a broadband network has a significant impact on democracy, economy, and society, indicating the importance of policy to increase broadband penetration.

Countries like South Korea, Japan, Canada, India and Egypt have all issued and implemented conscious policies for the growth of broadband in their respective countries. Likewise, the government of Pakistan (2004) argues that these policies have included growth enablers such as price reductions for use of infrastructure, unified licensing for service providers, government setting of strict annual broadband penetration targets, content and e-commerce development incentives and lowering of the price and tax barriers on broadband terminal equipment.

In Republic of the Congo, broadband is developing faster than the regulation. If there is no judicious catch-up, consumers and users will lose the benefits of strong

regulation, such as reasonable tariffs, good quality of service, universal access and growth. In the absence of a regulatory environment, there exists a risk of creating failure in the market, which can lead to losses in the economy and to social welfare. Above all, policy should explain the goal of broadband for the country, and create a regulatory environment where broadband proliferates.

In Republic of the Congo, the most recent ICT Act was issued in 2009, while the take-off of broadband development in the country only began in 2011. Policy and regulation now need to be reviewed and adapted to the new environment, characterized by the rollout of broadband infrastructure including the construction of the undersea cable system. "Regulation that guarantees open access, enforces reasonable pricing plans, and encourages innovative content could help establish the identity of this new technology and kick start its diffusion" (Papacharissi & Zaks, 2006).

Msimang (2011) notes four factors leading to success in the deployment of broadband in Kenya: (1) a clear national vision articulated in its Vision 2030, (2) strong leadership and direction, (3) a credible regulatory, policy and institutional framework, and (4) leveraging the strength of public and private sectors through the PPP model. In addition, a focus must be put on the development of skills. As discussed in greater detail in Chapter Four, Republic of the Congo has an ICT vision titled "Congo Digital 2025" (MPTEN, 2019), but the document does not set clear objectives for broadband. This potentially limits the policy and regulatory leadership for broadband. The sector law is old (2009), and was not designed to take broadband into account. In such a situation, regulations could be issued to advance the market and protect consumers, which has occurred to some extent.

It is important to note that policy aims only to pave the way to achieve goals. The actual growth will depend on the initiatives taken by other stakeholders and service and content providers "[…] to capitalize on facilitations brought by relevant policy, and help in creating and meeting the demand rather than just meeting it" (Government of Pakistan, 2004). Policy alone is not sufficient; actions must follow to implement policy on the ground.

The resistance to interconnection in reasonable terms usually happens due to the lack of binding regulation. Efficient interconnection will only occur, if the regulation forces it (Melody, 2001). In the case of Republic of the Congo, a regulatory intervention for broadband interconnection is strongly needed; otherwise, the ICT market is left in crucial disarray with disastrous consequences on the economy and social development.

At present, Republic of the Congo does not have a policy on broadband access, service, usage and quality. The regulatory framework on the matter exists but is

rather weak and covers only the issue of license regime. Theories show that policy and regulatory frameworks are necessary for competition to function and growth to occur. Indeed, "If a country decides to create an enabling policy environment, it will have to implement specific regulations supporting this decision. Moving toward an enabling environment will at least require a review of policy and regulatory frameworks" (Kim, Kelly & Raja, 2010).

The establishment of a regulatory framework "precedes the roll out of broadband infrastructures and the development of a market. Hence, accelerated rollout of new services and networks should start by cleaning up the regulatory framework to accommodate new technologies and business models" (World Bank, 2010). Even though the roll out of the broadband in Republic of the Congo is already underway, it is imperative that regulation quickly adapt to this new reality.

2.2 Broadband and socio-economic development

There is no doubt that access to ICTs positively affects growth and socio-economic development. Williams (2010) argues in support of the emerging evidence, which suggests that access to more ICT services, such as those that require broadband connectivity for delivery, can also have positive economic and social impacts. The penetration of broadband results in the increase of the national wealth.

Studies have shown that an increase in the broadband penetration rate by 10 percentage points yields an additional 1.38 in GDP growth (ITU, 2012a). Furthermore, high-speed Internet via broadband infrastructure may accelerate the distribution of ideas and information, and foster competition and development of new products, processes, and business models, thereby further facilitating macroeconomic growth (Czernich, Falck, Kretschmer & Woessmann, 2009). However, this statement is only verifiable, if the roll out of high-speed infrastructures and related e-services are developed in the context of efficient regulation and policy frameworks.

The government of Pakistan (2004, p.3) states that:

> Broadband access is widely recognized as a catalyst for the economic and social development of a country […] It allows people not only to communicate, but also to do business more efficiently over longer distances, be better educated, have access to better health services, benefit from better governance, and have enhanced entertainment services.

In their respective reports, Gillett, Lehr, Osorio, and Sirbu (2006) on one hand, and Crandall, Lehr, and Litan (2007) on another hand exploited the differences in broadband development across the United States, and found such positive

associations between the broadband penetration and economic outcome variables as greater employment, higher wages and housing prices. If the development of the broadband ecosystem in Republic of the Congo has been developed in such an efficient manner, the country could draw crucial benefits including in terms of business development and the improvement of public services delivery. Broadband is really a factor of growth. In the US for example, one percentage point increase in broadband penetration corresponds to 0.2 to 0.3 percent increases in job creation. Broadband allows for high-speed data exchanges, empowering and fostering the e-services delivery in various fields such as health care, continuing education and banking.

Broadband drives the digital economy. "Virtually as many countries in the world have started making plans for the development of broadband, countries and firms that lack access to modern systems of telecommunications cannot effectively participate in the global economy. This applies to the least-developed countries of Africa […], which aspire to join the ranks of industrial countries in the decade or so" (Saunders, Warford & Wellenius, 1994). "[It] drives intensive productive use of ICT applications and services due to [its] greater integration in the global value chain than even before" (OECD, 2008). Discussing the state of broadband in 2018, the Broadband Commission pointed out the trend in the development of broadband anywhere in the world. In LDCs, by end 2017, the number of mobile-cellular subscriptions reached about 700 million, with a penetration of 70%. Next-generation ICT infrastructure will power many digital solutions from smart cities to public and financial services (Broadband Commission, 2018).

Republic of the Congo is engaged in the broadband roll out, which will assist in boosting the contributions to the service sector and he national GDP, and subsequently improve citizens' life. First and Mellor (2005) argue that "broadband has the potential to offer the improved quality of education and health services, improved connectedness of government with society, and to provide jobs and prosperity". When the development of broadband is a reality, people will be able to draw the sought after benefits of broadband.

2.3 The undersea cable system

Undersea cables (modern cable systems) play an important role in conveying telecommunications traffic (voice and data) through T1-backbones around the world. "Modern cable systems are now designed as long loops, connecting two landing stations in one country, which are separated by some hundreds of kilometres, from two similar landing stations at the other side of the ocean" (Williams, 1997). As with any facility in the telecoms sector, the undersea cable and the landing station need to be regulated to lower prices and foster competition in the market. The high price of the international bandwidth is a consequence of a lack in competition that can occur

by the presence of monopoly control of facilities such as the submarine cable landing station. The lack of competition resulting from the monopoly control of such facilities has harmful consequences that obstruct the economic growth and a wide range of other important factors that contribute to the progress and general welfare of a country' (ICC, 2007). Competition is paramount in the undersea cable market, otherwise there is a risk for prices to increase and for quality of service to be poor along the chain of value in reaching consumers.

As with any public policy, it is the responsibility of policy-makers to set the policy for broadband. The role of the regulator is to set a regulatory framework for the undersea cable, landing stations, backbone, and last mile. The objectives of regulating access to undersea cables and landing stations are to reduce the costs of international voice and data communications. In turn, this can be shown to benefit national competitiveness, boost economic growth and create jobs. It also helps to reduce the digital divide, to make services more affordable and thus to improve social cohesion (Esselaar, Gillwald & Sutherland, 2007, p.14).

At the time of this study, while the roll out of broadband is underway, no regulation exists to promote affordable access in the broadband market in the Republic of the Congo. The undersea cable connection has been in effect since the May 12, 2012, and since that time the Republic of the Congo has been paying trimestral fees to the WACS consortium. An ensuing paradox is that the use of bandwidth is very weak while the effective and potential demand is huge.

2.4 Interconnection and infrastructure sharing

For competition to be effective it is necessary to ensure that access to essential facilities are done in such a way that competition is maintained and fostered. In the case of broadband, the operability of the overall broadband infrastructures and platforms depends on the interconnection of networks of all operators. Melody (2001) further supports this and argues that, for telecom networks to function effectively, a high degree of co-operation is required from all parties involved.

There is a lack of coordination in the way broadband projects are implemented in the Republic of the Congo. As an example the technologies and standards of different operators are interoperable for the network and market to be extant. Indeed, the ground, Congo telecom is using CDMA and ADSL technologies to extend coverage through the last mile network in Brazzaville, some ISPs use WiMax. The regulator should ensure that all other technologies and platforms are interoperable to avoid 'patched networks' that reduce the value of the network.

As no framework of discussion exists between the regulator and broadband operators, there is a regulatory vacuum on the interconnection of broadband

networks. Failure to set an appropriate interconnection framework for broadband networks, will lead to major negative consequences for businesses and for the economic development of Republic of the Congo as a whole.

Naturally, the trend is for the operators to have anti-competitive behaviours, since these firms compete in both the backbone and the access parts of the infrastructure market, and as such policy and regulation should take proactive measures to prevent these behaviours. As the government is financing Congo telecom to develop the broadband network, policy and regulatory measures should be undertaken to protect 'small' operators. Zhen and Qiang (2009) critic the fact that where public operators receive funding from government, this weakens new operators in the market. The authors state that it would not be desirable for public funding to strengthen existing operators at the expense of new entrants. Congo telecoms and MTN must offer wholesale services at market prices. Conversely, the regulator must enforce the 'open access rules so that other operators can use mobile network operator (MNO) backbones, on equal and non-discriminatory terms and conditions, while competing with each other in the retail market.

The duplication of rival networks could be avoided by sharing facilities with competitors. In Nigeria, when the extensive fibre optic cable network rollout took place, operators entered into a variety of network-sharing agreements aimed at reducing costs and improving quality of supply (Williams, 2010). On the regulator side, when done appropriately infrastructure-sharing regulation reduces costs and fosters competition. A University of Massachusetts study discusses the matter of risk related to a non-appropriate sharing regulation. It states that "the sharing of infrastructure and spectrum, if not done carefully, creates a risk of cartelization that would keep prices artificially high and/or prevent new entrants" (Chapin &Lehr, 2011). Indeed, instead of duplicating networks, owners of essential facilities must give access to new entrants, preventing any probable investment in similar facilities.

Competition in broadband markets matter, Choi (2011) argues that considering the characteristics of broadband as a network, many governments introduce service-based competition, which is assumed to lower entry barriers by allowing entrants to lease incumbents' facilities, as a stepping stone to facilities-based competition. Applied in the Republic of the Congo situation, Congo telecom should share its facilities (landing station room, backhaul pipe and others) with other operators that need to connect their equipment and deliver services. This must be applied also to private companies such as MTN-Congo, as it has capacities on the undersea cable. Several theorists have criticized the duplication of ICT facilities, and identified the lease of infrastructures as an advantageous way, especially for new entrants to make profits and growth. Guthrie (2006), citing Hausman, highlights that in the case of US, access prices for leasing the incumbents' facilities, set by state regulators in line with a cost measures developed by the Federal Communications Commission (FCC), are

widely regarded to render seeking access more profitable than building rival facilities. Williams (2010) adds that by sharing facilities, operators increase their revenues and utilize spare capacity on their networks.

> When it comes to investment, government funding could be used to install passive infrastructure (poles, conduit, etc.)—representing the highest-cost portion of new network investment, often cited as close to 80 percent of total cost (Gauthey, 2006)—which can then be used by various operators (Zhen & Qiang, 2009).

A regulatory framework for infrastructure sharing exists in Republic of the Congo. Any operator can use the facilities of others. While this may apply in general to broadband, this regulation in infrastructure sharing needs to be updated in order to take into consideration the development of broadband. Indeed the infrastructure to be shared goes beyond towers and includes concrete culverts. It is important that regulation is adapted in order to take into account new infrastructure such as concrete culverts.

2.5 Broadband spectrum and digital migration

Broadband technologies such as CDMA, 3G, and LTE require the allocation and assignment of radio frequency spectrum. The spectrum is the only way to efficiently extend broadband to areas where it is difficult to have wired medium. A license is required for an operator to use spectrum. Usually the regulator grants spectrum to telecommunications providers. Notably, as indicated by CCK, the Kenyan regulator, broadband licensing should be granted, "based on the economic value of the spectrum in a manner that promotes its efficient use and sector growth" (CCK, 2012). In Republic of the Congo licenses to use spectrum are not priced in a way to take into account its value (services to be used, the range of the areas, sharing options). In order to efficiently use the wireless sections of the broadband network, care must be taken in the planning and management of the spectrum. The spectrum will enable developers to complete portions of the broadband network in areas where it is difficult to extend ADSL and fibre infrastructures.

The digital dividend (DD) refers to the release of spectrum after the analogue TV services have been closed down. The digital dividend is an opportunity for any country to enhance its global broadband capacity. Indeed, the spectrum that will be released after the migration from analogue television systems to the digital will make available additional wireless broadband capacity that can be used for broadband mobile applications and services (ITU, 2012b). Where the digital dividend has been effective, additional investments have been made and new jobs created. In addition, the digital migration and the digital dividend have fostered further creativity and entrepreneurship in the ICT sector in many countries.

The African Union (2012) recognized that when it argued that "the digital dividend at UHF band has a potential to provide mobile Internet broadband services to rural areas that will help greatly to fulfil one of the millennium development goals of bridging the digital divide".

Republic of the Congo has embarked on the spectrum migration process for digital television. As member of the ITU region 1, and based on the ITU WRC-12 spectrum allocation, the Republic of Congo is in this evolution process. The digital migration will be completed after the switch off of its TV analogue services the UHF band (694-862 MHz) and later the VHF previously used for TV will be used for mobile technologies such as LTE and other advanced technologies. As a consequence of the digital migration, Republic of the Congo will have additional broadband capacity to reach remote areas and fulfil its universal access and service duty. The digital dividend will allow for new investments necessary for the economy and growth of the country.

2.6 Market structure

The market structure for broadband is a matter of importance. A close examination of the market share data can provide key insights on the market structure for a given country. A regulatory intervention, generally through the open access model, is necessary to sustain competition on the downstream section of the network, including on the last mile portion. As such, the regulation should be set to allow competition in the wholesale and retail markets. The regulator should ensure the continuous positioning of regulatory procedures that foster competition in the broadband market.

While market forces are sufficient to guarantee competition in the broadband market, a strong regulatory procedure is necessary to deliver economic and social outcomes. In Canada in 2010, the lack of competition measures in the broadband market devastated the market and undermined the development. Gorp and Middleton (2010) argue that Canada's then market structure was not delivering competitive outcomes and noted that the broadband market was dominated by a few providers, and the services on offer were slower and more expensive than those available in other OECD markets. They further suggested that sole reliance on market forces to develop next generation infrastructures in Canada was likely to be ineffectual. To set competition in the broadband market, the regulator in the country must issue stronger regulation that will support any weak legislation that may be in place.

Often incumbent MNOs do not want competitors to sell or re-sell capacities. Indeed, some countries prevent mobile operators from selling support services to other operators on a wholesale basis. This action reduces potential demand for backbone services and therefore limits the incentives to invest in the infrastructure (Williams,

2010), as in the case of Burkina Faso where "the regulatory restrictions […] reduced the incentives for operators to invest in backbone networks, network investment has focused on lower-capacity wireless network" (Williams, 2010).

Market structure is key to the success of broadband. The monopoly, duopoly or other forms of uncompetitive market structures should be circumvented so that competition can be set and maintained. In Congo there are three large operators in the broadband market, one of which is the telecoms state operator Congo telecom, which owns the undersea cables and which is responsible for building the broadband backbone throughout the country. The two other operators are MTN and Airtel the main private mobile operators. Congo telecoms has a monopoly in the fixed broadband market, while MTN and Airtel have a position of duopoly in the mobile broadband market segment.

2.7 Universal access and service for broadband

Universal access and service (UAS) means the extension of ICT infrastructures and services to rural and underserved areas for people who previously could not afford access. Those who lobby in favour of the development of ICT in rural areas believe that the Internet is not just a means of communication but is also an enabler of livelihood in rural areas and, therefore, power (Jhunjhunwala, Ramachandran & Bandyopadhyay, 2004). The idea behind the UAS is to extend phone, Internet and broadband services to rural areas in order for people who live there to participate in the information society. The universality of access and services means that access and services should be affordable in disadvantaged areas and for the poor. The goal of widespread affordable access to mobile telephony is a sensible one, in view of the benefits in terms of economic growth, which such services can demonstrably bring (Cave, 2008).

Clearly, in developing countries, some areas may be too poor to justify network construction, so some kind of subsidies may be required to provide connectivity and deliver services. In Vietnam, a program was set with the objective, "to implement universalization of basic telecommunications services for rural residents in extreme poverty including providing 70% of communities with a public Internet access point" (Tran, 2011).

Universal access and service without broadband is simply nonsensical and a waste of resources. Indeed, broadband can bring specific services that people in rural areas need in order to participate in the global economy and knowledge society. However, in order for affordable broadband networks to extend into rural areas, public investments need to be used to connect hospitals, schools, libraries and other public institution on the last-mile (OECD, 2009; Chhabra, 2012).

It is the duty of governments to provide people with relevant services that enable a easy living. The view of broadband "as a universal service implies government involvement that will facilitate innovative content, affordable cost and the guarantee that the public interest will be served" (Papacharissi & Zaks, 2006). The government, by working as such will fulfil a part of its democratic duty. Noting the lessons learnt, the Republic of the Congo should integrate universal access for broadband in its strategy for the development of the broadband ecosystem. "Mobile broadband service has expanded rapidly across the globe and can undoubtedly provide a valuable information service to rural areas and lower income nations" (Thompson & Garbacz, 2011).

Having affordable high capacity access to rural areas is good, but beyond that, getting people to really use the infrastructure and services is challenging, thus mechanisms should be put in place to stimulate demand. Supply is senseless without demand. While addressing supply, public policies and investment for demand stimulation to facilitate broadband adoption are essential to the robust development of broadband infrastructure in the long run (Zhen & Qiang, 2009). For people to adopt ICTs, government must set mechanisms and incentive programs, which stimulates the demand. The government can do this by supporting small enterprises to create local content and develop new applications and services. In addition, policies and programmes should be developed to stimulate user-confidence to build trust of online services, and setting e-strategy programs such as e-government, e-health, e-justice and e-banking. M-banking should be encouraged by the Republic of the Congo government and the private sector. In fact, such programmes raise awareness of the benefits of broadband services and aggregate demand among potential users (Qiang & Rossotto, 2009). One way to stimulate demand is to follow the Ireland and Kazakhstan strategy approaches, where "government agencies help eligible households (such as low-income, elderly, or disabled persons living alone) pay for phone service together with other basic services, such as rent, food, or electricity (World Bank, 2009).

It is important to note that while the rollout of broadband in the Republic of the Congo is underway, specific mechanisms need to be set up to ensure that people in remote areas who are not familiar with ICT will use them. This stimulation of demand is very important to attract the requisite benefit of broadband to the maximum of citizens in the country.

2.8 Public-private partnership management model for broadband

Today many countries have changed their management model, by adopting a model that combines private and public resources. The public private partnership (PPP) (Frieden, 2005):

> …is an agreement between the government and private organizations to develop, operate, maintain and market a network by sharing risks and rewards. PPPs are a key element of sector reform interventions. 'Nations exhibiting best practices in ICT development clearly show the benefit of a combination of public and private initiatives.

The availability of investment capital is crucial to the development and expansion of robust telecommunication infrastructures. As developing countries often lack the capital, as well as the technology and managerial know-how, to develop broadband infrastructures, many governments have turned to private-public, domestic and foreign investors (Zhen & Qiang, 2009):

> The key to the success of PPP models will be ensuring that public investment crowds in, and does not substitute for private investment, and that the private sector has sufficient incentives to invest and operate networks efficiently.

With regard to regulation, regulators must create incentives for the incumbent and newcomers alike to invest in high-speed broadband infrastructures and services, where "the key driver for such investment lies in the development of sustainable competition with a multiplicity of operators in each of the technologies providing broadband services now or prospectively" (Frieden, 2005).

In Republic of the Congo, the World Bank is working with government to design policy, based on the PPP investment model. The Special Purpose Vehicle (SPV), a share ownership model is the chosen PPP model was recommended for this purpose for the country. Republic of the Congo would then lease the management of broadband to a new company under the PPP model.

2.9 Local content delivery

Application and service constitute an important component of the broadband ecosystem, necessary to derive consumer value. For the users, the network is transparent, meaning that people do not care about infrastructures, only content is of value to them. France outlined this perspective during the OECD meeting held in June 2002 in Seoul, when it stated that though networks play an essential role, they are actually just a means to access services and content, which are, for the consumer, the all added-value of broadband (OECD, 2002). In the Republic of the Congo, broadband networks largely deliver voice services, and to some extent, Internet services. Other important services such, as e-banking, e-government, e-health, e-education e-agriculture are not yet developed.

There is exigent demand from citizens for the use of new e-services and e-content, to engender a more affable lifestyle, and boost development, which goes with diversified broadband services (Word Bank, 1994):

> Diversifying supply of broadband services can attract new sources of capital and skills in the telecommunications sector, develop rivalry among services providers regarding performance and price, and generate cost benchmarks to guide pricing of monopoly supply.

To attract the maximum benefits of broadband, the government of the Republic of the Congo must find a way to produce and deliver broadband services and local content that is accessible and that people would be happy to use. Even with a broadband network in place, there are still challenges as to how to encourage people to use the provided applications and services. It would seem that to just provide access to broadband services is not sufficient means to ensure that the technology will be used (Yamakawa, Cadillo, & Tornero, 2012). Governments must set policies that will stimulate demand, otherwise, the demand will be weak if not inexistent in some areas. Korea is cited as an example in the stimulation of demand of e-services presented by Ovum (2009):

> The Korean Government's approach to promoting ICT in general and the broadband market in particular, has been to formulate strategic development frameworks through the use consecutive computerization master plans, which run over a number of years. Through each framework, the Government has outlined broad policy objectives, and has laid out a number of supply and demand-side supporting policies….
>
> It is significant that the Korean initiative was done in the context of an overall policy promoting broadband that included full market liberalization to establish infrastructure competition among operators and demand-side stimulation through initiatives such as ICT literacy training, free broadband access to all schools, 11 e-government projects, and support for the provision of inexpensive personal computers for low-income households. The result of this combined policy has been an explosion.

Once broadband infrastructures are in place it is necessary to have content, which people will need so that they can enjoy the network. Broadly the supply side of the broadband network ecosystem should be strengthened to the extent where the maximum number of people including those who live in rural areas are served. "Broadband policies should not only take care of the demand side of broadband services, but must also include direct or indirect support to the supply side" (Falch, 2006).

The development of broadband networks will need to go along with the development of skills for people to be able to use them. There are two types of broadband capacity – *network capacity,* i.e. the development of high-speed data communications networks, and *human capacity* enabling the use of the services through the development of relevant content and applications to promote the use of these networks. Building capacity in both areas is what will make broadband matter (Msimang, 2011, p.2). Capacity needs then to be built in Congo to learn why and how to develop local content. The incentive to push for more broadband services and content in Republic of the Congo also comes into prominence in this research.

Broadband is the vehicle to deliver content to users who request it. "The demand for broadband infrastructure is driven by the demand for content" (Falch, 2006). Furthermore, according to Papacharissi and Zaks (2006):

> Finally, the future of broadband depends on whether it will deliver content different from that available through other media, thus creating motivation for public adoption. If broadband becomes just another TV or radio, there will be little incentive for the average consumer to pay the extra cost to acquire it.

South Korea can again be taken as a good example with respect to the importance of local content delivery in the diffusion of broadband. "Broadband diffusion unfolded more quickly in Korea in part because of competition between the incumbent Korea Telecom and several new companies, and also because of the availability of attractive content" (Papacharissi & Zaks, 2006). Applied to content, diversity and market competition empowers the consumer to make choices. In Pakistan, the lack of local placements and local content and applications e.g. online stock market, online content in local languages, online education, e-government, e-commerce, home shopping, online games are cited as barriers to broadband growth (Government of Pakistan, 2004).

2.10 Consumer Protection

Consumers are one of the stakeholders in the broadband development process. They have a role to play, and have rights and obligations. While they use broadband services, they are also exposed to Internet threats and subsequent abuse from service providers. The concerns to consumers occur in relation to the pricing of broadband, quality of service, and universal access and service. A strong regulatory environment is essential in order to efficiently address these issues. In addition, the establishment of a strong sector law to safeguard regulation must pave the way. In line with this view, Lewis and Southwood (2010) claim that "governments should strengthen the provision in law that empowers the regulator more effectively to protect consumer rights in communications". ~~B~~broadband uses are similar across fixed and mobile users, suggesting that the technologies are somewhat substitutable from customers'

perspectives and raising the possibility of limited differential effects on innovation and other social goals (Hauge, Jamison &Macu, 2007). However, policy is a key question when it comes to consumers' protection. Indeed, prior to the legislation and regulations which will create an environment for consumers' protection for broadband, policy should first be instated. South Africa's policy for broadband provides for some activities on which to assist consumers. The following statement is found in its policy document, South Africa Connect (Republic of South Africa, 2013):

> Furthermore, the policy provides for the implementation of campaigns to educate and create awareness with regard to the benefits of broadband. This will build confidence in the use of broadband services thereby in increasing uptake and usage of such services.

For individuals not well informed on broadband related-issues (benefits, threats, uptake and usage) this policy can promote less difficult participation in the national broadband project.

2.11 Analytical framework for the Republic of the Congo broadband ecosystem study

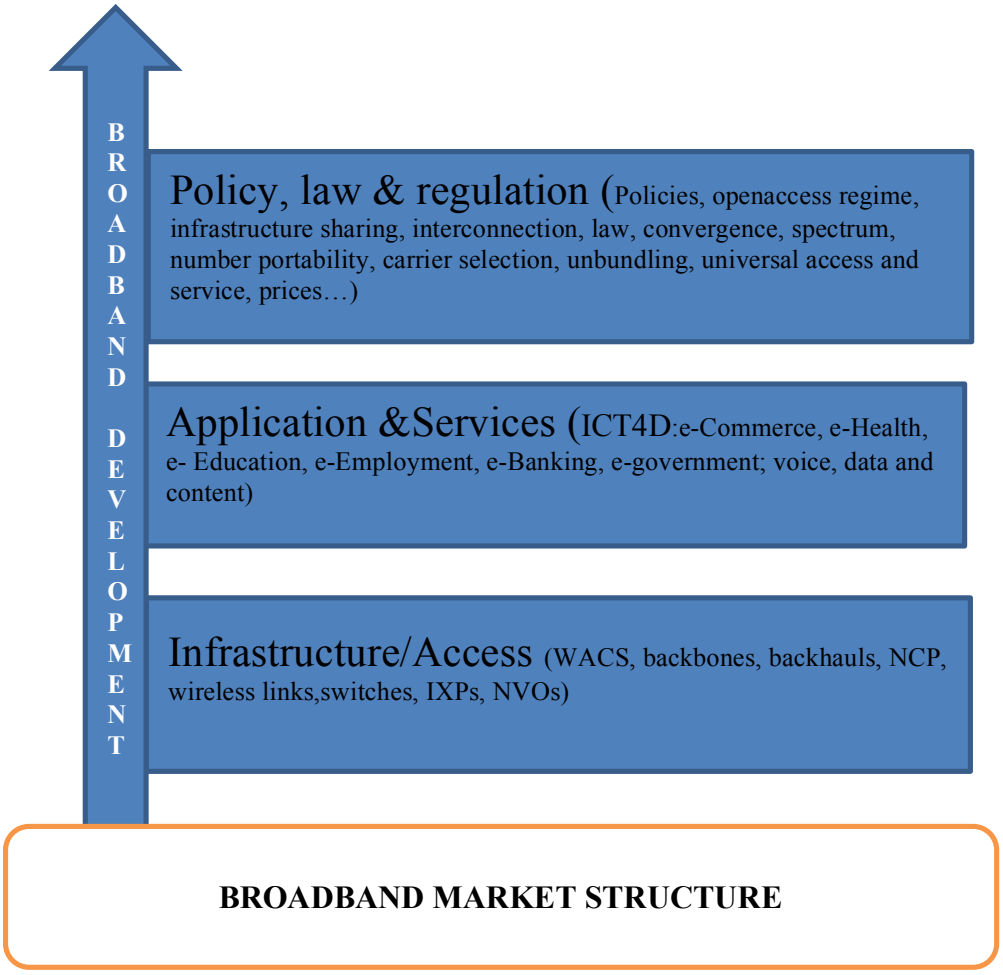
The analytical framework for this study has four layers.

(1) Infrastructure: Undersea cable, national backbone, middle mile, last mile access and spectrum licensing.
(2) Broadband market structure.
(3) Internet-based applications and services.
(4) Policy, legislation and regulation for the broadband ecosystem.

Each layer represents a component through which the development of broadband in Republic of the Congo passes. The first component is related to infrastructure composed by networks, cables, and all ICT systems. Above that layer is a second component, which deals with services (Internet access, e-banking, e-government, e-commerce, etc). The third layer of the analytical framework deals with policy and regulation, without which the development of broadband is not possible. All these layers affect the broadband market structure. The overall objective of the development of the broadband ecosystem in the Republic of the Congo presented though this analytical framework is related to the development and growth of the country's economy, which should then positively impact peoples' lives and welfare.

The development of broadband depends on infrastructures, policies, laws and regulations which form part of the broadband ecosystem and on which the broadband market is based, as indicated in the analytical framework below.

Figure 2.1 Analytical framework



Chapter Three: Case Study Research Design and Methodology

3.1 Qualitative Methodology

Qualitative research is characterized by its aim to relate understanding to selected aspects of social life; its methods (in general) generate words, rather than numbers, as data for analysis (Bricki & Green, 2016). Thus, a qualitative method is appropriate for this research as the research seeks to understand a specific aspect of social life, which understands the relationship of policy and regulation to the development of broadband ecosystem in Republic of the Congo. In the qualitative approach of research, "theory is built from data or grounded in the data.

Researchers must use theory to support their approach of conducting studies. The theory makes qualitative research flexible and lets data and theory interact" (Neuman, 2011, p.157-158). The researcher endeavoured to conduct an in depth investigation, relating the data to the theory studied in the literature.

The research approach is a single case study. This choice has been made to focus on understanding the dynamics present in single settings (Eisenhardt, 1989), representing a single set of empirical circumstances, where the findings can be generalizable to other empirical settings when additional cases test and confirm those findings in other settings. Single cases allow researchers to investigate in depth to provide rich description and understanding (Yin, 2009). In addition, the "how" research question qualified the case study methodology as the ideal instrument for the investigation for this research (Darke, Shanks & Broadbent, 1998; Yin, 2009). Case study research may adopt a single-case or a multiple-case design (Yin, 2009). This work used a *single* case study, because this case study can be considered an exploratory and an explanatory study (Yin, 2009), being the first academic study of policy and regulation for the broadband ecosystem in the Republic of the Congo. A single case study is appropriate where it represents a critical case, where it is an extreme or unique case, or where it is a revelatory (exploratory) case (Yin, 1994).

The Republic of the Congo has spent more than 10 years and invested several USD million in broadband development, hence this case can be considered as critical, and therefore it merits the single case study approach.

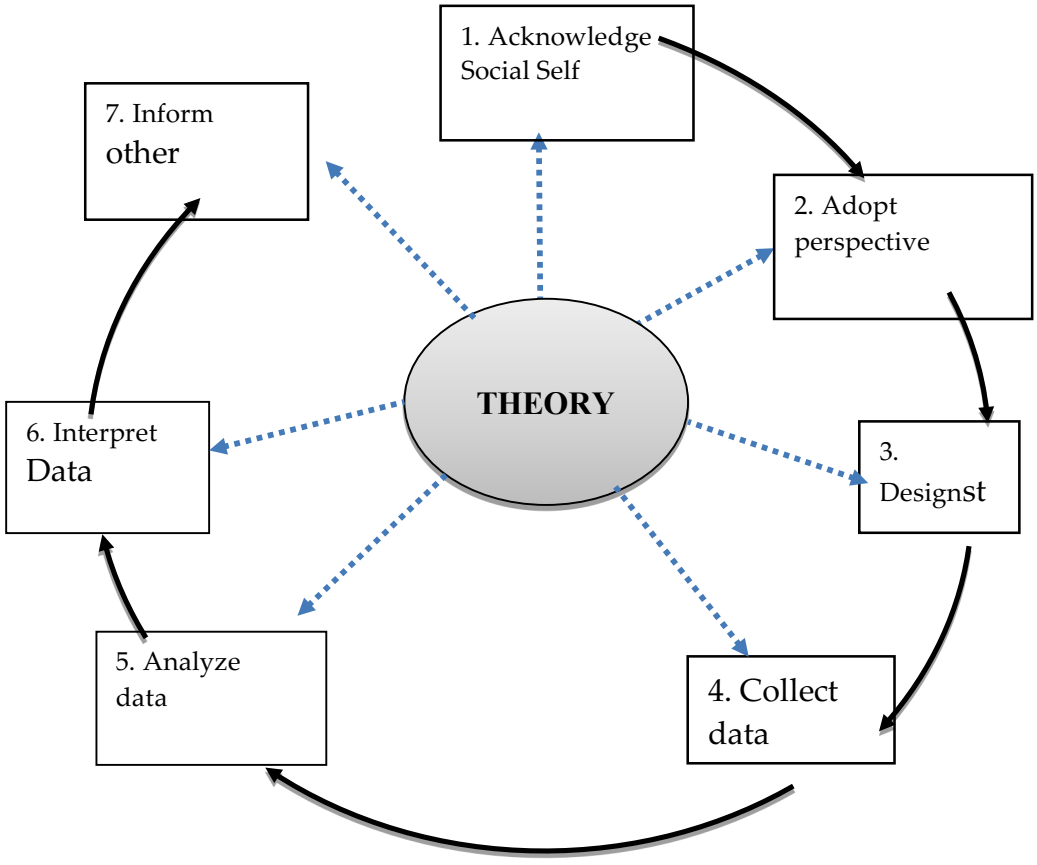
One advantage of qualitative methods in exploratory research is that the use of open-ended questions and probing, gives participants the opportunity to respond in their own words (FHI360, 2011). This study capitalises on this with the selective use of open-ended questions in the interviews. Furthermore, qualitative research allows the respondents to give much 'richer' answers to questions put to them by the researcher, and may give valuable insights which might have been missed by another method (Lacey & Luff, 1997). Document review and interviews were the

instruments used to get details and to learn the 'story' behind the problem under study.

3.2 Qualitative Research Process

To achieve the objectives of this study, the research overview approach was adopted from Denzin and Lincoln (2003). In the sections below, the researcher describes how this process was applied. Denzin and Lincoln's (2003) research design model, describes a sequence of seven main steps, see Figure 3.1 below. Each step is grounded in theory, with each step operating in the context of another. For case studies, theory development as part of the design phase is essential, whether the ensuing case study's purpose is to develop or to test theory (Yin, 2009).

Figure 3.1 Qualitative research process: Denzin and Lincoln



Source: Denzin and Lincoln, 20 03

In these authors' approach, the sequence begins with the acknowledge social-self step and ends with the 'inform others' step, as illustrated in the diagram above. In this model the theory seats in the centre, fuelling each component of the research process. Neuman (2011) argues that the research process is not strictly linear, it may flow in several directions before reaching an end (Neuman, 2011). The research goes through all seven steps, and returning to previous steps when necessary.

3.2.1 Acknowledge social self

The self-assessment can be the starting point when conducting research. The self-assessment is what the researcher is acknowledging *vis-a-vis* his/her position in the society. In any research approach the researcher does not focus on a specific topic or question, rather he/she uses theories in an inquisitive and open-end setting. My position as an IT patrician with nine years' experience at the telecom/ICT regulatory agency makes me appropriately knowledgeable of the socio-historical context of the topic under study.

3.2.2 Adopt perspective

The researcher might be in a position where he/she self-consciously applies any perspective to explore the issue under study, positioning him/herself in the context and environment in which the study is being conducted. By virtue of nine years working for the regulator and three years' prior as a telecom engineer in the Republic of the Congo, this researcher is in a position to clearly understand the situation of the development of broadband in the Republic of the Congo.

3.2.3 Design study, scope and limitations

Designing the study involves choosing the type of sample to select, deciding how to measure factors, and developing a research technique to employ e.g. questionnaire, interview etc. This study took place in the Republic of the Congo. The research technique used was interviews; where respondents were selected from across the telecoms/ICT sector, including government, operators, and consumers. For the interview process, open-end questions were used as the instrument to collect data. Purposive sampling was used (Patton, 1990); fifteen respondents were interviewed, carefully selected from among those knowledgeable on the subject of the development of the broadband ecosystem in the Republic of the Congo. Respondent selection was based on one criterion. In order to qualify for the study respondents must have been working within the telecoms/ICT sectors in Republic of the Congo for at least five years.

Triangulation is a way of mixing research designs. "Triangulation is the combination of at least two or more theoretical perspectives methodological approaches, data sources, investigators, or data analysis methods. The intent of using triangulation is to decrease, negate, or counterbalance the deficiency of a single strategy, thereby increasing the ability to interpret the findings" (Thurmond, 2004). "The triangulation approach allows an investigator to obtain a more integrated view of the communication that occurs within interpersonal networks […], and of how such communication leads to the development of new knowledge" (Lievrouw, Rogers, Lowe & Nadel, 1987). In this study, data was collected through limited observations of the broadband infrastructure part of the ecosystem, document reviews and interviews, in order to triangulate the data.

Though every effort was made to ensure a thorough evolution of the research process, there were some challenges worth noting. One major difficulty encountered was the paucity of available data related to the ICT sector of the country. Although an attempt was made to include all aspects of the broadband ecosystem as it applies to the Republic of the Congo, the researcher did not address in detail any issues that were not related to the policy and regulation perspective, or where only little data was available. The researcher has attempted to manage his own biases given his employment at the sector regulator.

While the sample size used was deemed to be sufficient to the subject focus, noting that "qualitative inquiry typically focuses in depth on relatively small samples" (Patton, 1990), the respondent numbers could have been expanded, thereby providing a greater range of responses. A sample can be limited to a reasonable number of people to be interviewed. "Qualitative data analysis eventually reaches a point called saturation. This is the point where new data and their sorting only confirm the categories (often numbering between three and six or so), themes, and conclusions already reached" (Miles & Huberman, 1994). In other words, after a certain sample size it is not necessary to add either interviewees or data as that will not provide further themes, insights and perspectives (Suri, 2011) or change the findings and conclusions. Furthermore, Miles and Huberman (1994):

> In general, good analysis uncovers better understanding of a phenomenon or process. Some qualitative researchers prefer to use the term *understanding of data* instead of *analysis of data*.

In the process of the collection of data we quickly reached data saturation. Although the sample size of this study was relatively small (15 respondents), we reached the point of saturation after nine interviews. When, during the interview, people started providing the same information (redundancy) that had been provided by the previous respondents, it was understood that the point of data saturation had been reached.

3.2.4 Data collection

The qualitative data is derived from what the researcher experienced, remembered, and recorded in field notes (including maps, notes, diagrams, photos, etc.) when questioning or interviewing individuals (Kvale & Brinkman, 2008). In research the quality of data comes into prominence. For a qualitative researcher, high-quality data are reliable and valid as they give precise, consistent measures of the same "objective" reality for all researchers. Neuman (2011) explains that good quality data can guarantee the success of the rest of steps of the research process. The researcher selected 15 well-informed respondents to get quality data and used open-ended questions in the interview guide to give participants the opportunity to respond in

their own words so that they could give rich answers to the questions and provide valuable insights. The structured interview processed, also called a standardized interview, was used in which all respondents are asked the same questions, using the same wording and followed in the same sequence (Corbetta, 2003, p.269).

Table 3. 1 Table of respondents

Respondent Pseudonym	**Organisational context (government, private sector operator, regulator, consumer)**	**Type of knowledge**
Respondent 1	MPTEN	Degree, experience
Respondent 2	ARPCE	Telecoms regulatory matters
Respondent 3	University (academia)	Academic, relevant knowledge
Respondent 4	Consumer	Telecoms knowledge
Respondent 5	MPTEN	Senior manager
Respondent 6	MPTEN	Degree, experience
Respondent 7	Operator	Senior manager
Respondent 8	Operator	Senior manager
Respondent 9	Consumer	No special knowledge
Respondent 10	Regulator	Economic knowledge
Respondent 11	MPTEN	Degree, experience
Respondent 12	Operator	Tech engineer
Respondent 13	Regulator	IT engineer
Respondent 14	Regulator	Degree, experience
Respondent 15	Civil society	Involved in ICT matters

The researcher has given consideration to a number of ethical issues, with respect to interactions and interviews with respondents. Ethical issues include (i) the researcher works for the regulator and declared this to respondents (ii) the general requirements for research ethics including anonymity and confidentiality were applied.
The next step is to analyse the content of key policy documents and regulations. In this regards (Neuman, 2011) recommends that this is done by the following means:

> A content analysis is a detailed and asymmetric examination of the content of a particular body of material, for the purpose of identifying patterns, themes or biases…The content refers to words, meanings, pictures, symbols, ideas, themes or any message that can be communicated.

In this study, content analysis was applied to interviews and documents, including policy documents and publicly available reports. The theory on content analysis indicates that data analysis consists of bringing meticulously collected data to respond to the research question. In research the trustworthiness or merit of inquiry

comes into prominence. “Research findings should be as trustworthy as possible and every research study must be evaluated in relation to the procedures used to generate the findings” (Graneheim & Lundman, 2004). Trust value “establishes how confident the researcher is with the truth of the findings based on the research design, informants, and context” (Krefting, 1990). In the research process the researcher needs to consider the credibility and consistency of data as well as the applicability (to other contexts and settings) and neutrality of findings.

3.2.5 Data analysis

The aim here is to give meaning to the analysis of the data, while new concepts may be developed to support interpretations and present conclusions. Based on the background knowledge of the research question and the topic under study, the goal of interpreting data is to answer the research question – the key objective for any research.

Qualitative researchers look for patterns or relationships early in research, while they are collecting data and use analytic memos to note down thoughts and ideas. The analytic challenge for the qualitative researcher is to reduce data, identify categories and connections, develop themes, and offer well-reasoned, reflective conclusions. This is a process of tearing apart and rebuilding abstract conceptual linkages, requiring synthesis and creative insight, changing one’s “lens” to reconstruct an interpretation, and definitely carefully documenting the process to enhance the credibility of findings (Miles & Huberman, 1994). The analytic memo forges a link between the concrete data or raw evidence and more abstract, theoretical thinking (Neuman, 2011). In this study, the researcher investigated documents, graphs, photos and interviews that provided understanding of the issue under study. Analysis involved the organization of data so as to identify what trends are extant in the data. Data were analysed by drawing inferences from the particular response from interviews, noting correlation between responses. Lastly, the researcher deals with interpreting data by using theories and his knowledge of the situation in the field.

3.2.6 Inform (Appraisement)

In this last step of the research process, the author makes available the research report to a professional audience about the study. The report should be directed at a specific audience (Neuman, 2011), in this case the policy and regulatory stakeholders in the Republic of the Congo.

3.3 Chapter conclusion

The chapter has set out the details for the case study research design.

Chapter Four: Outline of the development of the broadband ecosystem in the Republic of the Congo

This chapter presents data on the development of broadband in the Republic of the Congo, it is divided into sections corresponding to the four groups of themes that emerged in the analytical framework design:

(1) Infrastructure: Undersea cable, national backbone, middle mile, last mile access and spectrum licensing.
(2) Broadband market structure.
(3) Internet-based applications and services.
(4) Policy, legislation and regulation for the broadband ecosystem.

This chapter discusses each of the above themes and presents tables, notes, figures and pictures as part of data. Fifteen interviews were conducted with key respondents from the government (telecoms ministry and regulator), the state telecom operator named Congo telecom, private telecom operators, academia and consumers. Respondents were selected based on their knowledge of ICT matters, and their experience with respect to the broadband development process. Issues that emerged from document review and interviews with respect to each theme are presented in the table be low and then discussed in the relevant sections. Local content delivery, one of the important components of the broadband ecosystem, was excluded from the list of issues that emerged during the interview phase, because it was not possible to collect relevant data on that matter.

Table 4.3 Themes and corresponding issues

Theme	**Emerging issues**
4.1.1Infrastructure: Undersea cable and the landing station at Matombi	- WACS project - Consortium and agreements -Budget and investments - Capacities and system design - Landing stations at Matombi -Broadband benefits for Republic of the Congo - Backhaul and terminal station
4.1.2 Infrastructure: National backbone–NCP	- Network rollout and technologies -Funding - Management and skills
4.1.3 Infrastructure: Central African Backbone	-Backbone link to the neighbour countries -Funding -Internet Exchange Point -Status and challenges
4.1.4Infrastructure: Middle mile (local network)	-Current status (South, West, East, North) -Interconnection
4.1.5Infrastructure: Last mile access	-Congo telecom as a fixed line operator -Operators on the last mile segment -Technologies -Current status of last mile
4.1.6Infrastructure: Spectrum licenses	-Technologies -Spectrum licensing
4.2Broadband market structure	-Competition on the mobile market -Pricing at the wholesale and retail markets -Tele density
4.3Internet-based applications and services	-Internet-based applications -Services delivered -status and problems
4.4 Policy, law and regulation for the broadband ecosystem	-Policy on broadband -Legislation for the ICT sector -Regulations for broadband -Problems

Source: Researcher's table, 2018

Table 4.2 Broadband network characteristics

WACS	14000 km	Monomode undersea cable cable	5,12 Tbps	SDH, WDM, CDWM	Data, dark fibre culvert	WACS members
NCP	1801 km	Monomode G652	2Mbps, 10Gbps, STM-1	SDH, WDM, CDWM	Voice, data, dark fibre culvert	Operators, ISPs, administration and business
CAB	~ 1078 km	Monomode G652	2Mbps, 10Gbps, STM-1	SDH, WDM, CDWM	Voice, data, dark fibre culvert	Operators, ISPs, administration and business
Congo Télécom	9 km	Monomode G652	2Mbps, 10Gbps, STM-1	SDH, WDM, CDWM	Voice, data, dark fibre, culvert	Operators, ISPs, administration and business
SNE	1801 km	Monomode G652	2Mbps, 10Gbps, STM-1	SDH, WDM, CDWM	Dark fibre	Congo Télécom
PRCTG					Data, dark fibre culvert	Administration

Source: ARPCE, 2019

Figure 4.1 below shows the 2019 optical fiber map for Republic of the Congo. This chapter explains key parts of the process to arrive at the 2019 deployment of Congolese broadband networks.

Figure 4.1 2019 fiber map with CAB in red and NCP in green

Source: ARPCE, 2019

4.1 International infrastructure perspective

The Republic of the Congo started to build its broadband infrastructure in 2003, through the national backbone project (National Coverage Project or NCP). However, at that time, the country missed the opportunity to connect to the SAT3 undersea cable. "That decision was later considered to be a political mistake. At that time, the government did not understand the socio-economic relevance of connecting the country to an undersea cable" (Interview, Respondent 8, 2017). Until 2011 the only way for the Republic of the Congo to connect to the world was by using satellite technologies. In 2009, the government commenced its participation in the WACS undersea cable project, which accelerated of broadband infrastructure. In 2018, the Republic of the Congo is involved in three main infrastructure projects of which one is completed (WACS), one is partially completed while already in use (NCP), and one project is underway and planned to be completed in December 2019 (CAB).

4.1.1 The West African Cable System (WACS): Global infrastructure for African broadband connectivity

The West African Cable System (WACS) was created by a South African initiative to build an undersea cable along the Atlantic West Coast. The South African government initiated the WACS project as a collaborative effort of African governments and leading telecommunications operators (Brand South Africa, 2012). The plan was to build an undersea cable that would link South Africa to Brazil, and South Africa to the United Kingdom. Originally, that undersea cable project was known as the Africa West Coast Cable (AWCC), with a plan to branch to South America. When the proposed route to Brazil was dropped leaving only the UK segment, the project became the West African Cable System (WACS) (Resolvy,2011). WACS has 15 landing stations along the route, which includes South Africa, Namibia, Angola, Democratic Republic of Congo (DRC), Republic of Congo, Cameroon, Togo, Nigeria, Ghana, Ivory Coast, Cape Verde, Canary Island, Portugal, and the UK with an additional point of presence in London (MTN, 2015).

WACS is an important piece in the global backbone puzzle. The project was designed to support present and future Internet, e-commerce, electronic data and cloud, video and voice services, for the benefit of Africa. The purpose of WACS is to increase overall bandwidth/capacity for transmission of electronic voice and Internet data in the host countries, with the associated benefits of faster, more reliable access and more competitive pricing (WACS, 2012). The challenge for WACS was to address the affordable access problems experienced most by Africa's disadvantaged communities and to stimulate economic growth. In this way the continent could aim to bridge the digital divide thus enabling millions of Africans to be part of the digital age.

Figure 4.2 WACS route and landing stations along the Atlantic west coast

Source: Infraco, 2012

WACS is a consortium of 12 members, or landing parties, from 14 countries, who signed a partnership agreement in April 2009. WACS is an operators' project, in that the consortium is constituted of 12 public and private telecoms/ICT operators. Each consortium member had the duty to obtain the necessary licensing to land the cable, build the landing station, and provide the necessary infrastructures to connect the cable to the domestic terrestrial communication network (The Namibian, 2012). The Republic of the Congo is represented in the WACS consortium through Congo telecom, the state telecom operator.

The WACS is an 11,451 km cable system that stretches from Yzerfontein (South Africa) to Seixal (Portugal), with additional segments, from Seixal to London (United Kingdom), making WACS, at 14,500 km, one of the longest sub-marine cable segments in the world. The system has 11 suspenders that connect the landing stations of 11 countries to the undersea cable thereby extending the system to 17,200 km of undersea fibre optics. The WACS was commercially launched in Cape Town in May 2012 (MyBroadband, 2012). The initial budget for WACS was set at USD650 million of which the Republic of the Congo should have paid USD19 million, see Table 4.3 below. The WACS project exceeded the provisional budget, with an actual total cost of USD764 million (WACS, 2012), of which the Congo telecom investment was USD25 million (WACS, 2012). In most cases, members of WACS made individual investments in the project, while in the case of the Republic of the Congo the Congo telecom investment was made by the government through the Treasury. "In all other country members of WACS, it is the telecom company that directly invested in the project, it is only in Republic of the Congo that the government invested on the behalf of the local telecom company" (Interview, Respondent 3,2018).

Table 4.3 WACS investment breakdown

Party	Initial Investment	Initial Capital Cost sharing
	(US$)	(%)
Angola Telecom	$90,000,000	11.780105%
C&W	$90,000,000	11.780105%
Infraco	$90,000,000	11.780105%
MTN	$90,000,000	11.780105%
PTC	$50,000,000	6.544503%
Tata Telecommunications	$75,000,000	9.816754%
Telecom Namibia	$75,000,000	9.816754%
Telkom	$75,000,000	9.816754%
Vodacom	$79,000,000	10.340314%
Togo Telecom	$25,000,000	3.272251%
Sotelco	$25,000,000	3.272251%
Sum	**$764,000,000**	**100.000000%**

Source: WACS, 2012

All investors signed both the WACS Construction and Maintenance Agreement and the Supply Contract, on April 8 2009. On April 9 2009, the WACS consortium awarded the construction of the undersea cable to Alcatel-Lucent. The Supply Contract came into force in May 2009. Each WACS consortium member signed a turnkey contract with Alcatel-Lucent for the deployment of the WACS undersea cable. Alcatel-Lucent Submarine Network was contracted to supply the 1400-km network (Resolvy, 2016).

The WACS design capacity is 5.12 terabits per second while the actual bandwidth utilisable is 500 Gigabits per second, upgradable at any stage of the project (WACS, 2012). The 5.12Tbps corresponds on average to 500 STM-1 lines or 30,000 E1 lines per country. "In the Republic of the Congo in 2017 only 8 STM-1 lines out of a possible 500 were activated" (Interview, Respondent 7, 2017). The undersea cable system uses the dense 128-wavelength division multiplexing (DWDM) technology, in compliance with the latest technology developments. With that technology the system can be upgraded from the 5.12 Tbps design capacity to as high as 30Tbps (WACS, 2012).

The cable landing station houses the DWDM gear, power plant, back-up generators, fibre endings and IT infrastructures (Congo telecom, 2016). Through interviews the researcher learnt that Congo telecom does not organize regular visits of the Beach ManHole (BMH) and Landfall Point, an action crucial to the realisation of its operational status through lessening probable risks of erosion or other threats.

4.1.2 The WACS undersea cable: Landing station at Matombi

In 2007, the five largest South African telecommunications operators namely MTN, Neotel, Telkom SA, Vodacom and Infraco commenced work on the West Africa Cable System (WACS). The WACS project was planned to setup key landing stations along the West Coast of Africa, especially in countries with public telecom operators holding international telecoms licenses. Thus, the WACS project presented a new opportunity for Republic of the Congo to connect to the undersea cable, one of the critical steps for the development of broadband in the country. Republic of the Congo joined the WACS-Consortium through Congo telecom, the state telecoms operator, in May 2009. In 2017, there were17 international telecom carriers who were members of the WACS consortium (WACS, 2017).

In Republic of the Congo, the WACS cable lands at Matombi, a small village near Pointe-Noire. The launch of this landing station took place on 25 October 2012 (Congo telecom, 2012). The cable system used by WACS is the 16201620 LM - SLTE Submarine Line Terminal Equipment. It connects the Matombi landing station to an undersea cable node in the ocean, 300 km away, with four repeaters along the way. The distance between the landing point and the landing station is1.8km. The cable goes through a concrete culvert to the data centre (see Figure 4.3 below).

Figure 4.3 Landing station data centre at Matombi, Republic of the Congo

Source: The researcher, 2015

In 2013, the total investment made by both the consortium and the government to finance the WACS project was USD30 million. This amount is broken down as shown in Table 4.4 below:

Table 4.4 Payments made in Congo for the WACS project

Amount paid USD	**Purpose**	**Paid to**	**Paid by**
25 million	Congo telecom investment in WACS	WACS Consortium	Government of the Republic of the Congo
5 million	For the management of the WACS project	Ministry of Posts, Telecommunications and the Digital Economy (MPTEN, or telecoms Ministry)	Government of the Republic of the Congo
30 million	Total		

Source: WACS, 2013

Each WACS consortium member has to contribute to the network maintenance and service (M&S) costs by paying fees to the consortium. The Republic of the Congo investment in WACS was USD25 million which corresponds to 3.27% of the WACS' project budget. The Republic of the Congo government committed to pay an extra USD500,000 to the telecoms Ministry, for the administrative management of the project (WACS, 2012). The government also committed to build an electrical power line between Pointe-Noire and Matombi, in order to bring the main power to the landing station. In the launch phase of WACS, Republic of the Congo was provided with an initial capacity of 640,000 STM1xkm, which corresponds to segment number 5 (T5) on the WACS system (WACS, 2016).

Table 4.5 Allocated, assigned and activated capacities for each party on WACS

Party	Allocated Capacity	Assigned Capacity	Activated Capacity	AllocatedUnactivatedCapacity	Entitlement to Design Capacity	Remaining Entitlement to Design Capacity
Angola Cables	4,767,273	1,846,735	1,846,735	2,920,538	42,159,364	37,392,091
C&W	4,767,273	2,872,860	2,872,860	1,894,413	42,159,364	37,392,091
Congo Telecom	654,270	39,376	39,376	614,894	5,786,035	5,131,765

Source: WACS, 2016

In December 2015, only 0.06% (39,376 Gig) had been activated corresponding to 8 STM-1 lines, a capacity equivalent to 5,131,765 Gig that might be activated and used in the future (WACS, 2018).

Table 4.6 Republic of the Congo activated capacity breakdown

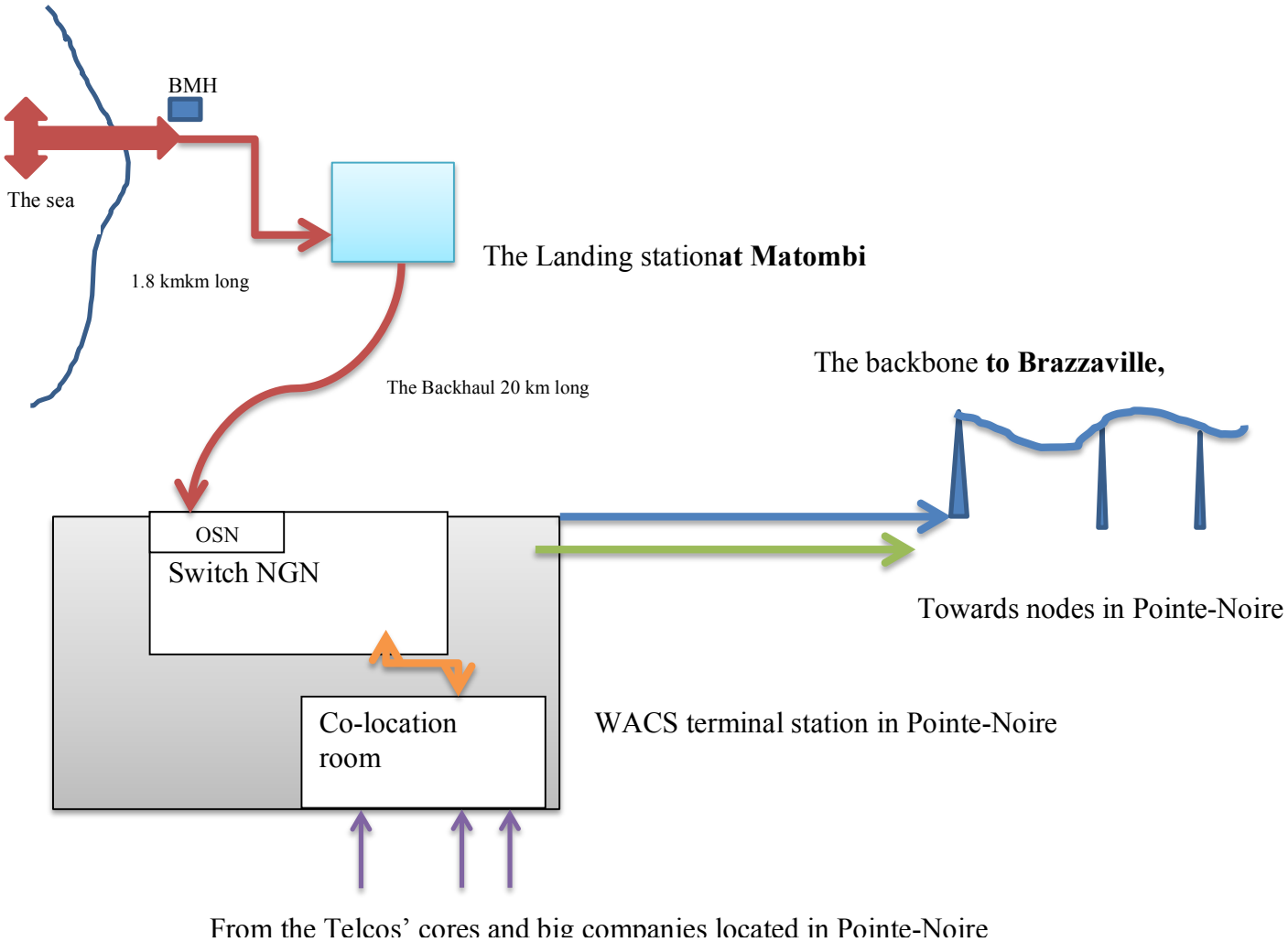
	Number of activated STM1 lines	**Capacity in Mbps**	**Direct departure point to the core network**
Congo telecom	3	465	WACS terminal station in Pointe-Noire
MTN-Congo	2	310	*Sympathique* district in Pointe-Noire
Airtel	3	465	*La Gare de Pointe-Noire*
Total	8	1240	

Source: Congo telecom, 2015

4.1.3 Backhaul and terminal station

In telecommunication, the backhaul network comprises the link between the core network and smaller sub-networks. In the specific case of the landing station, the backhaul corresponds to the link that connects the landing station to the terminal station where the core network is located. The landing station in Matombi and the terminal station located in Pointe-Noire are separated by 20 km of terrestrial backhaul, see Figure 4.4 below. To connect to the undersea cable, operators and ISPs must first connect to the core network at the terminal station located in Pointe-Noire. At the upstream part, ISPs can connect users through the middle mile and then the last mile segments of the network. Big private companies in Pointe Noire, mainly in the oil sector, such as Total SA or ENI-Congo SA are directly connected to the terminal station. The terminal station has a co-location room where all networks (NCP, CAB, ISP, and major operators) can interconnect.

Figure 4.4 Fibre path from the sea to the terminal station though the landing station at Matombi



Source: Researcher, 2017

In the early years of the project there was no main power supply at the landing station in Matombi. The power system consisted of two generators each of 450 KVA that ran, alternating every 6 hours, to ensure the continuity of the power supply and to avoid power failure. This is an unsafe practice given the importance of landing station infrastructure and the potential risk of failure of the system. For example, from October 22 to December 21 2012, only one of the two generators worked. In addition, the maintenance activities that were planned did not occur, despite the allocation of a budget to Congo telecom by the Consortium for that purpose. The common exchange between the generator's tanks is 12,000 litres, and only 800 litres were provided per day. There was no main power at the landing station, because the power line had not been built as the government was committed to do. Thus the risk of interruption of power was indefinitely pending.

The backhaul system is an OSN 7500 (Huawei) equipment owned by Congo telecom. In Republic of the Congo, the backhaul cable is grounded along the way (Congo telecom, 2016), while the norm recommends instead that it be placed in a reinforced concrete culvert. It is noted that the backhaul cable was cut four times in the years between its placement and now (Interview, Respondent 13, 2018). The technical mismanagement of the landing station by Congo telecom was often expressed during the interviews. Some interviewees report that since the landing station was launched, no follow up actions were taken by Congo telecom, regarding the technical management of the system: there is no maintenance plan, no scheduled training, and no available technical documentations exists. The landing station system is run without a team that can handle any crucial intervention.

With respect to the backhaul high speed link that connects the landing station with the core network, in a good design, the backhaul has a backup to prevent risk of failures in the main. In the Republic of the Congo case, the backhaul between the landing station and the core network does not have a backup. This situation leaves the country at risk of traffic cut offs. The landing station at Matombi should have a backup link to connect to the core network, as that would protect the country from a possible incident on the backhaul cable (sabotage, vandalism, etc.). The cuts of the cable that connect the landing station to the core network have already occurred in the past. The backhaul cable was accidentally cut more than three times, firstly on November 24th 2012, then in January 2013 the cable along with the SNE cable burnt under the *Sangolo* Bridge, resulting in 48 hours of down time. Secondly, the cable was severed by a backhoe on February 25th 2013, when fortunately, the system was restored after 24 hours. The third accident occurred on May 27th 2013 at the *Guerin* location causing an 18-hour discontinuity of service. Under these operating conditions, the risk of traffic cuts of unpredictable duration is permanent. A backhaul cable should go through a reinforced concrete tunnel along the 20 km between the core network and the landing stations. It is crucial that this corrective work be urgently undertaken.

As an international infrastructure, WACS must be connected to the national backbone from which it receives traffic to be forwarded to the internet. The national backbone infrastructure is established through the National Coverage Project presented in the next section.

4.2 National Coverage Project (NCP)

The national backbone network is built through a project named National Coverage Project. The NCP bridges the WACS undersea cable facilities and the (middle mile) access networks. The NCP consists in building ICT infrastructures "throughout the country to provide services to schools, hospitals, administrations, companies and households" (Interview, Respondent 7, 2017).

4.2.1 The network rollout and technologies

The NCP objective is to connect towns and districts throughout the country by fibre optic infrastructures in order to provide broadband connectivity in the country.

Figure 4.5 NCP backbone route

Source: Congo telecom, 2018

The NCP consists of an optical fibre network that goes from Pointe Noire (in the South) to Ouesso (in the North East). From Pointe Noire to Brazzaville there are two backbone lines, one aerial and the other underground. The aerial line was set up in 2011. It is laid along the high power electric line and uses the SDH technology with a capacity of 20Gbps. The second line, inaugurated in January 2018, consists of a single mode optical fibre cable using the DWDM technology with a capacity of 220Gbps (observation, 2018). "Between Brazzaville and Ouesso the NCP backbone consists a SDH fibre optic line, while from Oyo to Ouesso the line is extended with the CDMA wireless technology to remote areas where it is difficult to lay cables" (Interview, Respondent 9, 2017).

The NCP project was created in the framework of the Sino-Congolese cooperation through a debt of which the value has not yet been revealed. The NCP infrastructure is a critical national asset as it connects ISPs and end users to the Internet. The NCP provides the country's core broadband infrastructure for Internet access, therefore high technical quality is required for this asset. "I am not sure it is the case" (Interview, Respondent 11, 2016).

Set up in 2003, the NCP was planned to be deployed in three phases, each corresponding with a specific budget as shown in Table 4.7 below.

Table 4.7 NCP budget breakdown

	Objective	**Cost**	**Status**
Phase 1	To install 3 WNGN switches in Brazzaville, Pointe-Noire and Oyo, IXPs, a link to Kinshasa (DRC)	USD 90 million	Completed
Phase 2	To install WNGN in the main departments and lay backbone cable, and middle miles	USD 180 million	Underway
Phase 3	To install links to districts and large villages, and last mile and mobile(LTE) infrastructures	USD 200 million	Not started yet

Source: Congo telecom, 2018

4.2.2 Management of the NCP

All the interviewees presented a perspective on the manner in which the ongoing NCP project is managed. "The NCP seems to be managed by a single individual …. and this is a big concern" (Interview, Respondents 2 &11). Indications are that there have been no provisional specifications as to directions for management since the project started in 2003. Furthermore, on March 25th 2014, Congo telecom workers published a memorandum to complain about the mismanagement of the acting CEO in relation to the NCP. The memorandum specifies that NCP has not been producing relevant results.

Interviews also reveal that the NCP project lacks transparency, which appears to be a consequence of mismanagement. "Nobody really knows what is going on when it comes to NCP" (Interview, respondent 8). "No information is available to public: NCP is a big black box" (Interview, Respondent 6, 2017). An expert said that the management of the project is opaque and lacks transparency, the costs and expenditures of the project are unknown, and there is no available data of record (Interview, Respondent 14, 2017). "I am clearly pointing out the slowness of the government to take action on that matter" (Interview, Respondent 15, 2017). Interviewees indicate that what is required is for the government to set a stakeholder team in place to review the NCP, and set a roadmap for the smooth way forward (Interview, Respondent 14, 2017). "There appears to be a real need for an environment where all stakeholders are involved in the NCP, and where the governance problem is addressed". An expert (Interview, Respondent 11, 2018) expressed herself on the NCP lack of transparency and accountability. Finally, "I discussed with people who use Congo telecom services. They say that when the network works the service is good, but many times the network comes down or the internet is slow. When we call the companies they don't come, you have to go at their place and make a push for them to solve the problem" (Interview, Respondent 7, 2018).

4.3 The relevance of the Central African Backbone to broadband in the Republic of the Congo

The Central African Backbone (CAB) project is a cooperative project of the World Bank and central African states. CAB consists of constructing broadband infrastructures to connect the six Central African Economic and Monetary Community (CEMAC) countries + DRC + São Tomé and Principé + Niger + the Republic of Sudan and South Sudan, for a total of 11 countries.

The project development objective (PDO) was "to contribute to increase the geographical reach and usage of network broadband services, and reduce prices" (Word Bank, 2011). In that way, the CAB project expects to decrease prohibitive telecom costs, improve quality of life, and extend the coverage of telecom services. In the regional context, the PDO was consistent with the declaration adopted by CEMAC, calling for establishment of a regional Central African Backbone under the open access regime to regional connectivity infrastructure and public private partnership (PPP) principles (World Bank,2016).

4.3.1 CAB3 components and findings

In Congo, the CAB-project which started in 2012 is now at the end of its implementation (phase 3). The country has installed two cross-country high-speed links, one to DRC in 2014 and another to Gabon in 2017, which would normally put an end to phase 2 with respect to building the fibre network. The government is now seeking a company to exploit the CAB-network and commercialise its related services. The project completion enabled the 11 faculties of Marien Ngouabi University, the state university, to connect to the high-speed network in 2017. The last phase of the CAB in Congo (phase 3) aims to assist the development of local start-ups and create the national digital economic fund.

The CAB project for central Africa is structured in four phases: Phase 1 also known as CAB1 touches Cameroon, Chad and Central Africa Republic, CAB2 deals with Gabon, Equatorial Guinea and DRC, and CAB3includesthe Republic of the Congo. CAB3 (Project ID P108368) was approved by the World Bank on September 24, 2009.The project has four components that support the implementation of the four operational lines from the government ICT strategy which identified 18 sub-projects. Over those 18 sub-projects (P1 to P18), four (P1, P3, P12 and P14) have been realised in the framework of CAB3 (AfDB, 2016). CAB3 is structured in four components and each has a dedicated budgetary line item.

Table 4.8 Components of CAB and related budget for the Republic of the Congo

	Designation	**Objective**	**Amount in USD**
Component 1	Creating an enabling environment at the national and regional level to support the development of ICT legal framework	To strengthen regulatory framework (P3) and capacity of key stakeholders to provide policy and regulatory capacity building.	**7,100,000**
Component 2	increase connectivity	To provide broadband connectivity(P1) to the population and ensure implementation of a broadband national network	**18,000,000**
Component 3	Promotion of ICT sector.	To support the creation of IT MSMEs (P12) ,incubators IT parks (P14)	**2,000,000**
Component 4	Project Management	This component consists in financing the project's management-related (Monitoring and evaluation, and Audits	**2,000,000**
Contingencies			**900,000**
Total			**30,000,000**

Source: AfDB, 2015

Cameroon and Chad decided respectively in 2010 and in 2012 to withdraw from participation in component 2, and decided to build their backbone infrastructures in separate contracts. Those two countries decided to set national companies in that regards, and refused the PPP arrangements proposed by the World Bank which they considered as a violation of their national sovereignty (World Bank, 2016). However, in 2018 there is now a CAB4 project to connect Gabon to Cameroon and Equatorial Guinea (ITWeb Africa, 2018).

4.3.2 Funding related issues and CAB3's challenges

Originally the CAB3 budget for the Republic of the Congo was set at USD30 million, of which USD15 million is a loan from the World Bank, through an International Development Association (IDA) credit, and the other USD15 million is government counterpart funding. The World Bank funding became effective on December 15,2011 (AfDB, 2016). In 2016 it was noticed that funds under the original IDA credit became insufficient due to cost overruns, which made it difficult for the project to finance key equipment such as termination and shelter equipment planned to connect the country to Gabon, as originally planned. The reason for this break in funding was because the Republic of the Congo was not able to provide its counterpart funding,

due to the government budget constraints after the fall of oil prices in 2016 that struck the oil-based Republic of the Congo economy (AfDB,2016). On August 14 2017, Republic of the Congo and the World Bank concluded an additional funding (AF) credit (ID 5991-CG) in the amount of USD5million, which increased the IDA envelope from USD15 to USD20 million. As a consequence, the project would be restructured (and the results framework revised) to extend the closing date of CAB-3 from June 29, 2018 to December 31, 2019. In addition, the new loan would scale up activities under the component 3 of the CAB-3 project by establishing and providing seed money to the new Digital Development Fund (*Fonds de Development du Numérique*) (AfDB, 2016). The fund will support creation of SMMEs and IT incubators which would create new e-services and jobs (AfDB, 2016).

Table 4.9 CAB3's World Bank funding detail

Project name	**AFR: Central African Backbone - APL1A**	**Amount USD million**
Project ID	122398	
Bank approval date	September 24,2009	
Credit allowed date	May 25, 2011	
Credit signed date	July 15, 2011	
Credit effective date	December 12, 2011	15
CAB-3 original closing date	December 31, 2016	
CAB-3 revised closing date	June 29, 2018	
Additional funding		
Credit allowed date	August 14, 2017	
Credit effective date	October, 2017	5
Government additional funding (World Bank)		15
AfDB funding		63
Government additional funding (AfDB)		18
Sub-total loans		83
Sub-total government		33
CAB total funding		**116**

Source: AfDB, 2016

In project design, the World Bank requested that six audits be run to investigate any incidence of noncompliance and ineligible expenditures identified during the project process. Five split evaluation missions were planned, one per year on June 30, from 2011 until 2015, with a closing audit on December 30, 2016 (estimated) (AfDB, 2015). Audits would focus on both the project development objective (PDO) and on implementation through key performance indicators (KPIs). On March 9, 2017 the World Bank published its report on the third phase of the Central African backbone

(CAB3) project (Report ID PAD2129). The report indicated that in the five implementation interim status reports (ISRs) over the period June 2011 to June 2015, the CAB project in Republic of the Congo was rated satisfactory on PDO and KPIs.

In 2014 the CAB awarded a contract to Huawei to construct a fibre optic infrastructure from Pointe Noire to Mbinda, along the CFCO railway infrastructure, under component 2. The contract was split into two parts, with Part 1 (construction of optic fibre line) fully funded by CAB3 for the construction of optical fibre line, and Part 2, for which the cost was valuated to be XAF 4.2 billion for shelter and other active equipment, to be paid by government. In April 2016, government released the first tranche of XAF2 billion of counterpart funding, which enabled Part1 to be completed on October 31,2016. In order to launch Part2, the World Bank and Huawei requested evidence that funding is available. In July 2016, the government released XAF700 million. The proposed AF would close the funding gap needed to finance shelter and equipment expenditures necessary to strengthen achievement of the PDOs (AfDB, 2016).

On May 24th, 2016, the African Development Bank (AfDB) approved EUR52.04 million to the government of Republic of the Congo to help finance the CAB project to strengthen the fibre optic network construction and introduce e-services. Actually, the total amount of that AfDB's loan is EUR66,56 million, broken down as follows: EUR52,04 million as the loan and EUR14,52 million as the country's contribution to the project (AfDB,2016). A visibly frustrated interviewee was surprised by the multitude of funding for the CAB project "What a (predicament) to request a lot of additional money while with the first investment, no progress is noticed!" (Interview Respondent 5, 2016).

Along the way, the design of the project changed, and a Resettlement Action Plan (RAP) was prepared to handle changes that occurred. As an example of the changes, the activities of the project prepared to occur on the right side of the Congo-Océan railway were implemented on the left side instead, due to geographical constraints, which change resulted in no physical displacement of the land acquisition. This caused many other problems such as compensation for crop and fruit trees losses and as a consequence the budget was negatively impacted (AfDB,2016).

A risk to the Republic of the Congo CAB project outcomes was identified, related to the non-completion of the NCP, as the NCP would eventually need to be interconnected with the CAB and through it with WACS infrastructures. In case NCP failed, the CAB project would be useless (Interview, Respondent 15, 2018). "In 2011 when the CAB was launched, the government reassured the World Bank that the civil engineering works for NCP would be completed by June 2012, yet by 2018 the NCP is still underway" commented the same respondent. Related to the subject of risk, the calculated net present value (NPV) for the CAB project for Republic of the

Congo was estimated at USD16.4 million in the event of the NCP completion, and at USD10.5 million if not completed. The calculated internal rate of return (IRR) for the CAB3 project was estimated to be 21 percent if NCP succeeds, and 17 percent in the case of NCP non-completion. From a microeconomic perspective, the opportunity cost calculated to measure economies on the cost of providing bandwidth relying on satellite connection, as opposed to the CAB network, until 2024 was estimated to be USD22.5 million if NCP materialises and USD18.7 million if NCP does not materialize (World Bank, 2011).

The CAB-3 project is based on public-private partnership (PPP) arrangement that would leverage the necessary resources from the private sector allowing the country to benefit from innovative solutions, add foreign investment and the creation of job opportunities. In terms of economic opportunity costs, the latest transaction adviser for the PPP indicated that once the transaction for the commercialisation is finished the secession could generate important revenues for Republic of the Congo at the amount of around XAF150 billion (equivalent to USD250 billion at the current exchange rate) for a period of 20 years (World Bank, 2017b).

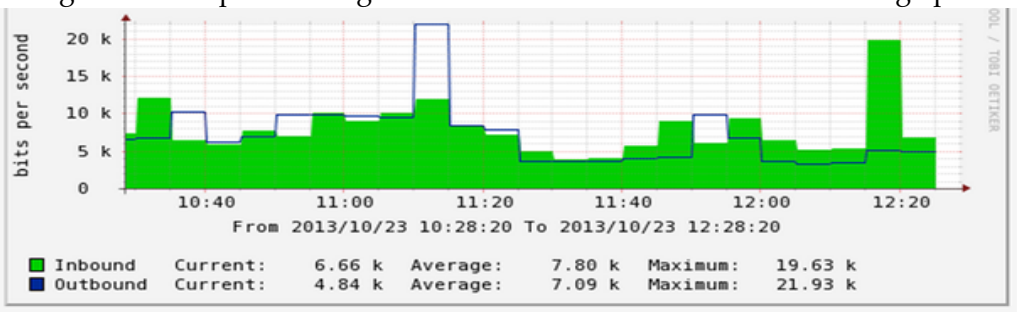
4.4 PRCTG and IXP: Two complementary broadband infrastructures

Apart from the core broadband infrastructures, namely WACS, NCP and CAB, Republic of the Congo has two other infrastructures that complete the network, namely PRCTG and IXP. PRCTG (*Projet de Renforcement de Capacité Gouvernementale*) is a project for building capacity for the governmental transparency. From the infrastructure point of view, the goal of the PRCTG project is to build a fibre optic backbone that would connect main administrations under the finance Ministry. The project was launched on May 15th, 2010 and ended on May 30th2014. Funding for the project comes from a loan from the World Bank in the amount from USD5,8 million in 2013 to USD 6,9 million. The PRCTG network interconnects 22 government administration centres, all equipped with servers and appropriate management software. A data centre was installed at the Ministry of Finance to manage transactions between those administration centres throughout the country. "While the PRCTG network with related-equipment is operational, the actual management activities are not yet effective" (Interview, Respondent 14,2016). The PRCTG is not connected to the NCP network and remains a closed network. "An isolated network in the interconnected world how so?" commented an expert (Interview, Respondent 12, 2016).

An Internet exchange point (IXP) is a physical location through which Internet infrastructure companies such as Internet service providers (ISPs)(connect) with each other (Cloudflare, 2016), created to maximize the part of the Internet service provider's traffic that goes through an upstream connection (Technopedia, 2016). In Republic of the Congo, it was decided, in the framework of CAB3 under component 2, to establish three IXPs, named CGIX (Congolese IXP) including one in Brazzaville,

one in Pointe Noire, and one in Oyo. Only the IXP in Brazzaville is up and running since May 13th 2013, those planned for Pointe Noire and Oyo were not yet established at the time of this study. The CAB3 budget to build three IXPs was USD500,000. A contract between ISPs was prepared by CAB3 setting conditions and processes to connect to the local exchange point and three ISPs (AMC, RTM, and RURA) were connected to the exchange point, while the remainder were not. It was also noticed that traffic of ISPs connected to the CGIX is very low, for example, traffic routed to the MTN network is around 20k/s. "Congo telecom is not connected on the CAB's IXP. It built its own(connectivity) … on NCP project, where no other operators are connected" (Interview, Respondent 3, 2018).

Figure 4.6 Graph showing the level of traffic at the Internet exchange point



Source: ARPCE, 2016a

An expert commented about the low data traffic volumes because of the lack of local content, emphasising why we need more. "It is in these kind of projects our money is going to, while we lack teachers in schools and medicines in hospitals!" (Interview, Respondent, 11, 2017).

4.5 Last and middle mile

The last mile also called (last kilometre) is the near to last portion of the communications network link to deliver connectivity to homes, administrations or companies. In Republic of the Congo, ISPs including mobile operators and Congo telecom, use various technologies as indicated in Table 4.10 below:

Table 4.10 Internet Providers by broadband technology used for the last mile

Operator/ISP	**Technology**
Congo telecom	ADSL, CDMA, FTTH
MTN	2G, 3G, 4G
Airtel	2G, 3G
ISPs	WiMAX

Source: ARPCE, 2018

From consumers, householders and some offices, the Internet remains extremely slow for these end-users in administrations, cyber cafés, etc., irrespective of technology. In Republic of the Congo in 2015, the percentage of householders with

Internet was 2.29, while the percentage of individuals using Internet was7.62 (Broadband Commission, 2016). At 31 December 2017, Internet penetration was 12 percent (Internet World Stats, 2018).

The middle mile is the portion of network that links ISPs' core networks to the network plant generally situated in the incumbent's main technical office. The middle mile provision helps non-incumbent ISPs to have access to Internet at low price. The Republic of the Congo has a middle mile network through NCP, but at the time of this study no ISP is connected to the NCP. "The network is available any operator who want to connect to our network can do so" commented an interviewee (Interview, Respondent 10, 2017). However, "we cannot connect to a network for which we doubt its technical expertise" (Interview, Respondent 11, 2017)."Open access regime must be set; we are waiting the regulator to act" (Interview, Respondent 7, 2016).

4.6 Infrastructure: Spectrum and licences

In telecommunication, spectrum is crucial as it allows the extension of digital services, in situations where cables cannot be used. All wireless technologies use spectrum to connect subscriber handsets, computers and other equipment to the core IT network. While ITU paves the way for the use of spectrum by setting international guidelines, each country should set legislation and regulation for the spectrum to be used in the country. Since 2015, Republic of the Congo has a frequency allocation plan (*Plan National d'Allocation des Frequences, PNAF*). The PNAF was issued by the Presidential Decree n° 253-2015 on the 19th February 2015 (MPTEN, 2017). The Republic of the Congo PNAF is based on ITU related guidelines. It shows the radio frequency bands the country allocates for different services and gives an overview of the national use of the radio frequency spectrum. For Republic of the Congo, ITU dedicated the 900 MHz band for mobile 2G and 1800 MHz for mobile 3G, 4G and eventually LTE technologies (ARPCE, 2017a). On the ground, local mobile operators avoid using 1800 frequency due to the high cost of setting 1800 infrastructures (Interview 11, Respondent 11, 2017).

Mobile operators have been granted licenses, while ISPs need just authorisations to run the network and provide Internet services to end users. Congo telecom does not have a license for the CDMA technology used (ARPCE, 2017a). Price through license fees can be an issue: one interviewee expressed his doubt on the alignment with regional standards with respect to the license that mobile operators have paid for since 2013 to be granted broadband mobile spectrum (Interview, Respondent 7, 2016).

Table 4.11 Operators' frequencies and technologies

Operator	Frequency	Technology	Licence granted year	Fees
MTN	EGSM 5Mhx	3G	2014-2024	NA/
MTN	1800	4G	2016-2024	10 billion XAF USD18,700,000,00
Airtel	2100 MHz	3G	2013-2023	N/A
ISPs	3.5 MHz	WiMax	-	-
Congo-telecom	800	CDMA	No	-

Source: ARPCE, 2018

4.7. Broadband market structure

The global broadband market is becoming increasingly mobile (PPC, 2017). The growth of Internet networks is creating broadband markets in many countries. According to ITU (2017) data, mobile broadband subscriptions grew more than 20 percent annually in the five years 2013 to 2017, and 4.3 billion people worldwide are expected to be using mobile broadband at the end of 2017. It is therefore important to know firms market shares, both in the wholesale and retail markets. Table 4.12 shows the operator market shares for Republic of the Congo, pointing out the technology used.

Table 4.12 Market share in the wholesale broadband market

Company	Network/Technology	Market share %
Congo telecom	DWDM SDH	94
MTN	SDH	6
Airtel	-	0
ISPs	-	0

In the broadband wholesale market, Congo telecom controls 94% of the market share. By having significant power on that market segment, Congo telecom can set prices to other broadband operators while competing with them in the retail market. This calls for regulatory intervention to protect the market. The regulator requests all wholesale broadband companies to set their respective price catalogues and send it to the regulator for review. We were not able to find these wholesale price catalogues, either with the regulator, or on the operators' websites.

As in some countries in Africa, in the Republic of the Congo there is a market leader in telecom tower infrastructure. While efficient regulation requires operators that own critical infrastructures to share them with others because of high cost required to build, in the Republic of the Congo, Helios Congo is a telecom tower infrastructure

company which is a leader in that market with 393 towers, followed by MTN with 302 towers (2018 data).

Table 4.13 Market share in the retail broadband market

Company	Network/Technology	Market share %	Customer
Congo telecom	ADSL FTTH CDMA	37	3000 -
MTN	3G 4G WiMax	28	1,082,091
Airtel	3G WiMax	14	759,974
ISPs	WiMax	24	

Source: ARPCE, 2018

In the telecoms industry, the market share is measured based either on revenue or on traffic in a year-long period. Below some key statistics from ARPCE the regulator agency:

Table 4.14 3-4G FTTH subscribers (data from December 2017)

Operator	3G, 4G subscribers	Data traffic (Mbps)	Revenue in XAF	Revenue in USD
MTN	1,001,268	409,425,372	1,527,410,913	2,857,260
Airtel	1,370,634	558,984,277	1,945,745,841	3,694,649

Source: ARPCE, 2017a

Table 4.15 WiMax subscribers (data from December 2017)

Operator	WiMax subscribers	Data traffic (Mbps)	Revenue	Revenue in USD
MTN	142	409,425,372	29,274,093	
Airtel	153	558,984,277	31,818,361	
ISPs	N/A	N/A	N/A	

Source: ARPCE, 2018

Table 4.16 Turnover on broadband Internet

	2016	2017	Growth
Revenue in XAF	XAF 36,900,035,506 USD 69,672, 066,75	XAF 42,017,700,760 USD 78,993,277,43	13.87%

Source: ARPCE, 2018

In Republic of the Congo, each broadband operator publishes its access retail prices for a variety of broadband offerings, including standalone and prepaid bundled services for many speed categories (21 for MTN, 24 for Airtel, and 3 for Congo telecom). Table 4.17 below shows the price of some selected speed categories by operator.

Table 4.17 Broadband retail price per operator

Operator	**Price for 512Kbps**	**Price for 1 Mbps**	**Setup fee + equipment**
MTN	80.000	N/A	60.000
Congo telecom	35.000	65.000	116.615
Airtel	190.270	N/A	125000

Sources: Airtel, MTN, Congo telecom (all 2018 data)

The retail prices above are for householders, and the paying model is prepaid, by month. In 2010, ARPCE conducted a public consultation on the broadband market. The consultation concluded that Congo telecom has significant power inthe fixed broadband wholesale market. In the retail market, MTN and Airtel share the mobile broadband market using 3G technology. All operators share the total of 3,4 million subscribers for all available technologies, namely 3G, WiMax, FTTH, and CDMA (ARPCE, 2018).

4.8 Internet-based applications and services

While broadband developed, Internet-based applications also emerged so that content providers can deliver services to end-users. An Internet-based application is any program that is accessed over a network connection using HTTP, rather than existing within a device's memory (Technopedia, 2018). In Republic of the Congo, the applications used by people are mainly the popular applications such as e-mail, Facebook and over-the-top(OTT) services such as WhatsApp, Viber and Skype. OTT refers to the service you use over the network services of your service provider (Lifewire, 2018), used to make cheaper and free calls using 3G networks. In Republic of the Congo, Facebook penetration is 5.3% (Allin1Social, 2018), compared to other African countries such as Chad (0.7%), Gabon (14.3%) or South Africa (20.2%) (Allin1Social, 2018). The top three Facebook pages in the country that belong to local organisations or people in terms of number of fans are: Airtel (216,300 fans), Denis Sassou Nguesso (206,537) and MTN (162,860) (Socialbakers, 2019).

In Republic of the Congo, broadband operators deliver only OTT services through the 3G data that users buy from them. The researcher did not find other types of services delivered by MTN, Airtel or Congo telecom, the three main broadband operator in the country. Moreover, in its development plan Congo telecom has only

started communicating about the triple play service (Internet, voice and TV over IP) that the company will put on the market in the coming two years (from 2019).

Only a few cloud services were found, such as an e-learning platform belonging to a local private high school. An interview respondent claimed: "we launched our e-learning services since 2007 and we have had 50 students from other African countries. From anywhere in the country people can access our school content and prepare for its certificates" (Interview, Respondent 14, 2018). In the banking industry, all the big local banks have the e-banking service for their respective clients.

The CAB project, in its component 3, plans to establish and fund the creation of IT medium and small-medium sized enterprises (MSMEs) and incubator IT parks, which will create applications and deliver appropriate services to local broadband users. The CAB-3 envelope for that is purpose is USD2 million (AfDB, 2016). One of the interview respondents was particularly interested in the content issue: "Local content is essentially missing, we are waiting for the e-government, e-health and other electronic public applications and services so that we can enjoy broadband with our relationship with the administration" (Interview, Respondent 15, 2017).

4.9 Policy, law and regulation

This section deals with issues related to the policy, legislation and regulation context surrounding the development of broadband in the Republic of the Congo. The goal of telecoms or ICT policy is to set a vision of a better digital world. The development of broadband has given opportunities to countries for placing new emphasis on the ability to establish sustainable policy, legislation and regulation for the ICT sector. Policy connects governmental strategies to actual people's needs and broadband development thrives when it becomes a national priority (Frieden, 2005). For this to happen, all stakeholders should be involved in the broadband development process.

As the literature attests, policy is key in creating propitious environments for the socio economic development of countries and people. Many countries such as Korea, Rwanda, Singapore, and South Africa have developed policies for broadband to enable development and growth. For example, the South African government vision is "to ensure universal access to reliable, affordable and secure broadband infrastructures and services by 2020, and stimulate sustainable uptake and usage" (Republic of South Africa, 2013). Moreover, considering Japan's and South Korea's success stories, we learn that government has an important role to play in setting the agenda for broadband roll out, and in promoting an environment that encourages investment, and innovation and consumer demand. Broadband Internet "has been imbued, in media coverage and popular debate, with revolutionary promise that cuts across traditional policy segmentation" (National Research Council, 2002).

Viewed through the lens of law, one way of understanding the communications law is to see it as being preoccupied with two main problems: allocating rights, and managing discrimination (Wu, 2006). With broadband development, this becomes more complex, as law should be applied to many issues, such as data protection, security, universal access, consumer protection, unbundling, convergence, net neutrality, competition and many other issues.

From a regulatory perspective, the broadband market should be monitored and regulated to avoid market failure and consumer welfare should be protected. For example, where regulators have acknowledged the dominance of one or more operators, a wide range of *ex ante* obligations can be imposed, including transparency, non-discrimination, interconnection and access obligations, regulatory accounting, accounting separation and price controls. The discussion below provides data on policy, legislation and regulation on the development of broadband in the Republic of the Congo.

4.9.1 Policy

In the Republic of the Congo, the telecom/ICT policy process began in 2004, when the UNDP agreed to assist to formulate an ICT policy document titled *Politique Nationale de Développement des Technologies de l'Information et de la Communication en République du Congo*. The policy document was reviewed twice, in 2007 and 2014. Albeit the documents ere drafted, they were not presented to the government for adoption and follow up.

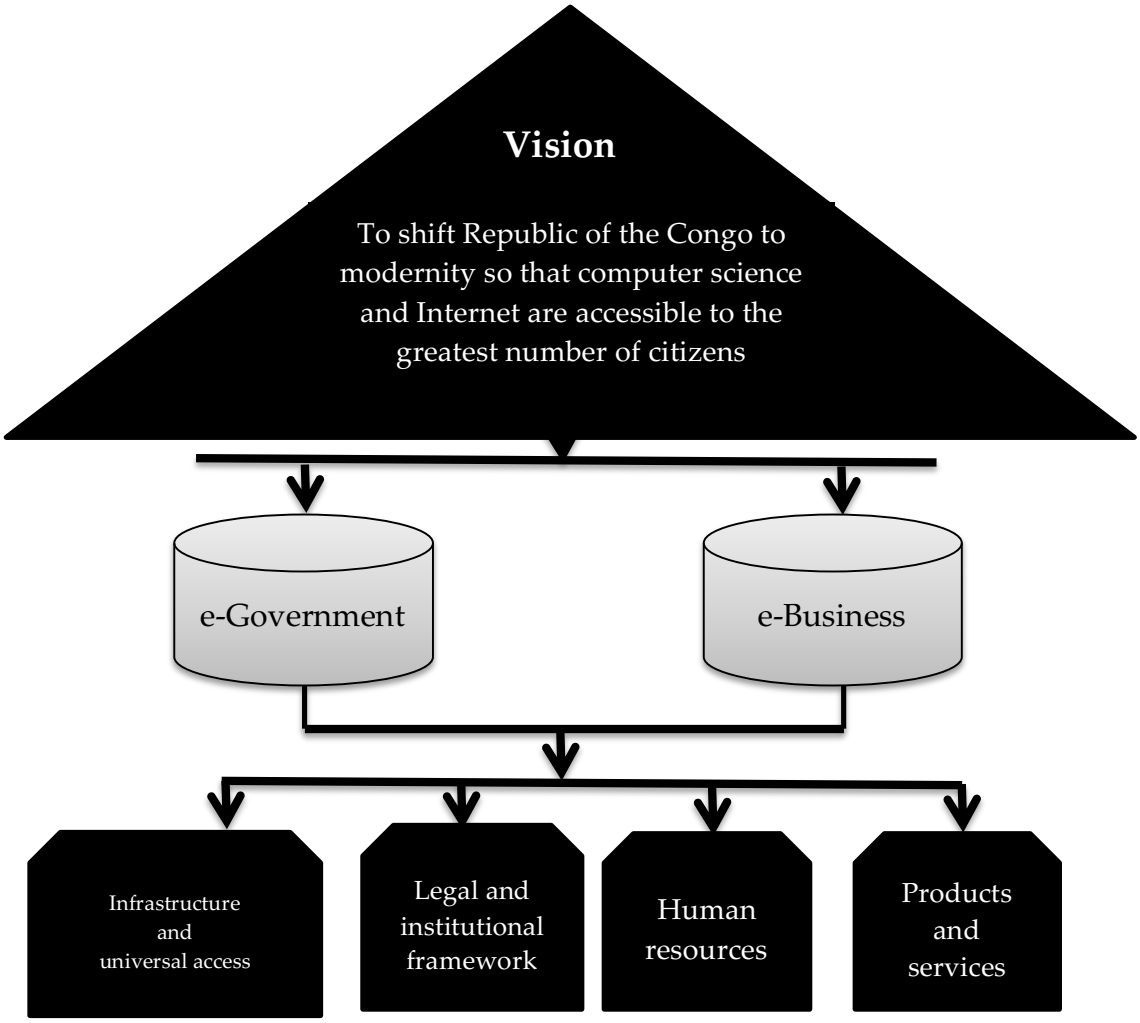
The 72-page draft policy document presents the national ICT sector status: market, legal framework, and areas for regulation. In the previous 2007 document draft, the ICT vision is expressed in the following way: "To steer Republic of the Congo to modernity, so that computers and Internet are accessible to the greatest number of citizens". This statement is derived from the end of the year Presidential Speech given in 2006. In the 2014 document, the wording of the vision was kept as is. This was a lost the opportunity to integrate broadband in the vision statement, given that broadband development was already underway (Interview, Respondent 13, 2018). The 2014 revision of the ICT policy was initiated and funded by the CAB3 project. The vision expressed in the 2014 document was focused on two pillars, e-government and e-business, segmented into four operational pillars (see Table 4.18 and Figure 4.7), then into 14 projects including infrastructure, regulatory environment, jobs creation, and other projects. The National Coverage Project (NCP) is one of the 14 projects.

Table 4.18 Republic of the Congo policy pillars and budget

	Pillar 1	**Pillar 2**	**Pillar 3**	**Pillar 4**
Pillar	Developing of infrastructures and promoting information society	Building legal and regulatory environment	Building capacities	Developing and promoting ICT services
Budget	USD124 billion	USD1600	USD2 million	USD19 million

Source: Ministry of Posts Telecommunications and the Digital Economy, 2014

Figure 4.7 Vision of e-government and e-business components



Source: Ministry of Posts, Telecommunications and the Digital Economy, 2014

The policy document concludes as follows (Republic of Congo, no date):

> The development of the national policy for ICT development is a crucial step to the entrance of Republic of the Congo into the global information society. For its realisation, Congo is committed to reducing its digital divide, and increasing its level of economic and social development. This strategy document must be completed by feasibility studies/programs/projects that will highlight the need in terms of financial resources.

The draft policy document also indicates risks that the related implementation process might face on the ground, among which are (i) the delay in the implementation of the NCP; (ii) lack of knowledge of ICT issues; (iii) lack of skills among different players; (iv) the high level of the deterioration of telecommunications infrastructures; and (v) the huge investment required.
These policies were not implemented. Subsequently, the new ICT policy, referred to publicly as "Vision Congo Digital 2025" (related to "Vision 2025 Congo") was finalised by decree in June 2019 (MPTEN, 2019) being a national strategy for digital economy development. This policy focuses on e-citizenship, e-government and e-business, but does not clearly define objectives to be achieved with respect to broadband, nor does it establish KPIs to assess the broadband implementation process. However, the universal access and service policy, including broadband, was also adopted by government in June 2019. The responsibility has been given to the regulator to implement the universal access and service policy, and manage the associated universal access and service fund together with the telecoms Ministry.

4.9.2 Law

In Republic of the Congo, the first telecommunications sector law is the Law 14-97, which came into force on May 24th 1997. This law was established in the context of a monopoly of the public telecoms operator. It dealt only with issues such as infrastructure, services and spectrum management, leaving out all Internet-related issues such as broadband, data privacy, broadband universal access, etc. In 2009, the Parliament established two new telecoms/ICT sector laws. The first, Law 09-2009 *(La Loi Portant Règlementation du Secteur des Communications Électroniques*) provides for the organisation and regulation of the ICT sector, while the second, Law 10-2009 created the independent ICT sector regulatory authority (ARPCE).

The mission of ARPCE is to regulate the digital communications sector, including telecoms and Internet environment. Furthermore, the 09-2009 law aims at organising competition in the ICT sector. It also addresses issues such as licensing, infrastructure sharing, interconnection, and universal access. The fact that there is no mention of broadband in the 2009-law is problematic. "An ICT law in the 21st century without dealing with broadband, how so?" (Interview, Respondent 4, 2016). However, the MPTEN has issued decrees on broadband, notably the decree n° 2011 – 734. This

decree set conditions for operators to operate in the broadband market in Congo. This text indicated that a license is required to operate broadband on the international segment, while only an authorisation is required to operate at national level.

4.9.3 Regulation

Like liberalisation and privatisation, regulation is a crucial component of the ICT sector reform. The success of the liberalisation process depends on the presence of a transparent and effective regulatory regime that enables the development of full competition, while effectively protecting other public interests (OECD, 2002). Broadband raises regulatory challenges as it addresses new issues such as technology convergence, competition, open access models, content development and consumer protection. Republic of the Congo takes the regulation of broadband as a crucial challenge to protect the market from failure, and to protect market players (operators and consumers) from various kinds of abuses.

The Republic of the Congo's electronic communications regulatory agency, Agence de Régulation des Postes et des Communication Électronique (ARPCE) was established in November 2009. Since then, no specific regulation relevant to broadband has been issued. However, the broadband market benefits from the general electronic communications market regulation, which addresses competition, prices, quality of service and consumer protection.

Republic of the Congo lacks the regulatory environment to manage the undersea cable. Indeed, nothing is clearly set in terms of regulation whereas the development of the broadband infrastructure is actually underway. When it comes to broadband, the regulator intervenes by setting regulations that addresses issues such as essential facilities doctrine, right of ways, and rate regime (wholesale prices for access to the cable). The only text that we found, relevant to regulation for broadband, is a decree that deals with the establishment and exploitation of broadband networks and services, Decree 2011-734 (Government of the Republic of the Congo, 2011). It states that to establish and exploit broadband networks and services for the international portion, an operator must have a license while an authorisation regime is applied in the national area. Despite this regulatory document signed by the President and issued on December 7th 2011, Congo telecom has never requested a license to establish and exploit broadband networks, including WACS and NCP.

From January 2013, MTN-Congo had 310 Mbps of capacity at the landing station, which it gets from the MTN-Group's whole capacity. In the absence of the regulation of broadband service, it is unclear if MTN-Congo can sell capacity to other companies or retail broadband resellers, and under which conditions (prices, quality, other conditions). "It is important to note that, in the absence of guidelines and rules

on broadband, MTN operates in both retail and wholesale broadband markets" (Interviews, Respondent 6, 2017; Respondent 8, 2017).

In 2010, the regulator commissioned its first broadband market study, now conducted every three years. This study aims to define relevant markets; set criteria to assess whether an operator has significant market power (SMP); identifying operators with SMP. The study is designed to provide the basis for remedial regulatory action to guide operators with respect SMP and possible abuse of dominance. The data for this study indicates that the wholesale (upstream) and retail (downstream) segments of the broadband market were considered as relevant markets. Markets were defined in terms of services that were considered to be substitutable from the perspective of their use, and sufficiently similar from the perspective of suppliers. In the Republic of the Congo, an operator is considered to possess dominance or SMP in the defined market, if their market share is greater than 25% in value, or in volume, or with respect to a service, or over a set of compatible services. The 2016 broadband market study shows that Congo telecom and MTN have SMP on the international wholesale broadband market with 58% and 42% of market share respectively. Moreover, on the 3G market, Airtel and MTN with 57% and 43% market share respectively, had joint dominance on the 3G market segments.

Between 2011 and 2017, the regulator issued a number of decisions to foster competition in the telecommunications markets, also relevant to broadband markets:

(i) The decision No 004/ARPCE-DG/DAJI/DRSE/11 that sets obligations and modalities for operators to share passive infrastructures (ARPCE, 2011).
(ii) The decision No071/ARPCE-DG/DAJI/DRSE/15 that authorizes Helios Towers (HT) company to rent telecoms towers infrastructures to telco operators.
(iii) The decision No 013/ARPCE -DG/DAJI/DEM/2017 that defines different markets and identifies operators that have SMP in given markets, and then indicates specific conditions that must be applied to them (ARPCE, 2017b).

The regulator, through the decision No 004 (ARPCE, 2011), required the operators with dominant positions in different market segments to conform to the following obligations:

1-publication of the technical and pricing interconnection offers
2-non-discimination
3-no excessive fees
4-analytical accounting
5-cost-based prices

Table 4.19 Broadband relevant market

Market type	Market	SMP	Market Share (percent)	Dominance Status
Wholesale	Access to WACS system	Congo telecom	58	
		MTN	42	
	DWDM backbone	Congo telecom	100	
	FH/E1 backbone	MTN	60	Yes
		Airtel	40	Yes
		MTN	42	Yes
	Telecoms Towers	Helios	42	Yes
		MTN	33	Yes
		Airtel	13	No
		Congo telecom	7	No
		Airtel	40	Yes
Retail market	FTH	Congo telecom	100	Yes
	ADSL	Congo telecom	100	Yes
	3G/4GAirtel	Airtel	57	Yes
		MTN	43	Yes
	MTN	MTN	6	no

Source: ARPCE, 2018

In the retail market, albeit that market has been declared relevant, the regulator prefers the self-regulation approach that leaves the market participants to set retail prices.

The effect of these actions in the market has led to the increase in the number of mobile broadband subscribers from 106,000 in 2013 to 925,000 in 2018 (ARPCE, 2019), and to the reduction of retail prices of mobile communications services from 25CFA to 3CFA/Mbps, in the same period. However, access to broadband and technologies remains a challenge to be overcome for a great number of citizens.

4.10 Conclusion

Data was collected about WACS, NCP and last mile infrastructure development, on the broadband market structure, on applications and services, and on policy, law and regulation. The following issues, which stand out during the data collection process, will be discussed in the next chapter: WACS has been completed and Republic of the Congo has high potential capacity on the system, but the country continues to endure access problems (low connection, high price). The NCP project began 14 years ago but currently there has been no effective project completion, preventing many citizens from having access to broadband services. Access remains slow at the last mile. Lack of local content undermines demand stimulation. Policy, law and regulatory frameworks on broadband are weak, particularly with respect to

competition. It would appear that there is limited knowledge and skills with respect to what is required to make (write) good policy and regulation.

Chapter Five: Analysis and Outlook on the Development of the Broadband Ecosystem in the Republic of the Congo

5.1 Introduction

This chapter presents the analysis of data for this study using the qualitative methodology outlined in the earlier chapter. The chapter analyses the data in relation to the analytical framework, the sub-questions and the main research question. The main research question was to understand how policy and regulation can address the challenges of broadband development in the Republic of the Congo.

5.2 WACS in Republic of the Congo: Some bottlenecks endured

The completion of the WACS project is a reality with all 15 landing stations up and running. The total capacity of the system is 500 STM1, which corresponds to 5.12 terabits per second. Despite the WACS progress, data show that the Republic of the Congo segment of the project has endured a number of bottlenecks that stand as the weak link of WACS capacity being available to the economy. Republic of the Congo and the WACS Consortium have made very large investments in the undersea cable project. The project, built from 2009 to 2012, has cost USD764 million. Capacity on the WACS cable is fully available in terms of bandwidth, however just a little of that capacity is used. This is not because the demand does not exist, but instead because the national broadband network is not functioning efficiently for a number of reasons, mainly because the national backbone project (NCP) is not completed yet. Another reason is the weakness of policy, and regulation, as well as the lack of skills in the field of policy and regulation. Furthermore, from data it emerges that there has been mismanagement in the NCP project by Congo telecom whose responsibility was to complete the NCP.

5.3 Understanding the status of the National Coverage Project (NCP)

The discussion on the NCP has raised a number of issues. In relation to the research questions, data reveals that no clear policy and no regulation framework are in place. Using the analytical framework of the study (Figure 2.1), the interpretation of data shows that the access layer created by the NCP infrastructure does not currently support the overall development of the broadband ecosystem. Failure in key areas of development for the NCP may underpin the overall failure of the development of the broadband ecosystem in the Republic of the Congo. From the literature review we learnt that regulation with respect to broadband markets is important for the adequate creation of an environment that fosters competition in the sector. However, a solution is also needed to the mismanagement problem indicated above, in order to inspire confidence, and attract ensuing investments and skills.

The data has helped to understand the status of NCP, as well as the challenges linked to that project. The relatively weak progress being made on the NCP in 16 years is a matter of concern. Indeed, interview respondents expressed concerns about the way the NCP is managed. It appears that no management team actually exists for the project. Rather, one individual manages the project. As a consequence, the NCP lacks transparency in the way it is managed. For example, there is no information of record published or presented as to the progress on the NCP, nor a strategy, nor information related to expenditures on the project are made available.

Since 2003, the government has invested around XAF160 billion (USD270 million) in the project with only the first phase of three completed. In addition to the mismanagement as claimed, data indicated the NCP suffers from lack of transparency and accountability. Data pointed out the lack of action from the government, to correct weaknesses in the way NCP is managed. In the interviews conducted, three views arose which explain the government's *laissez aller* approach. Firstly, it seems to occur as a result of the lack of adequate policy for the sector. In the absence of policy, it is difficult to have direction for a project such as the NCP. Secondly, respondents suggested that the fact that the project manager has political power prevents any corrective initiative which can change things. As anywhere, politics has continually disadvantageous effects for initiatives and projects in many countries, giving credence to the need for a democratic process. Lastly, the government has not historically recognised the economic and social value that the NCP can contribute to the development of the country. Thus, the historical lack of policy direction, the mismanagement and lack of corrective action in the NCP underpin the development of the broadband ecosystem in the Republic of the Congo. Building the understanding of the greater socio-economic value may be the only way the project would succeed. Future research will need to examine the effects of the Vision Congo Digital 2025, which falls outside the timeframe for this study.

From a technical perspective, the technologies (CDMA) used in the NCP may pose interoperability problems because of rapid changes in technology. The NCP network is planned to connect to other networks (CAB, WACS), but with the differences in technologies the interoperability between those different technologies could be a problem.

5.4 Other national backbone projects: PRTG, IXP and CAB

PRTG and CAB are two other backbone projects that constitute the National High Speed Broadband Network. The PRTG consists of the network connecting the administrations belonging to the Ministry of Finance. While data indicated that the project is completed, there is no significant traffic through the PRTG network. Another problem with PRTG is that, it is a 'closed network' meaning that PRTG is

not interconnected with other broadband networks such as NCP, CAB, local IXP, and WACS.

Data show that traffic captured though the local Internet Exchange Point (IXP) is too weak (20kbps) as compared to that in Kenya (250Mbps) or South Africa (3 Gbps). This insignificant rate of traffic at the IXP represents a waste of resources for a system that cost several billion in local currency to the country's treasury. Thus we conclude that the Republic of the Congo's Internet Exchange Point is, regrettably, underutilised.

The CAB backbone project connecting the central African countries aims to connect the Republic of the Congo to all its border countries via high-speed links. The link with DRC, in the framework of NCP, has already been built by Congo telecom. The CAB project commenced in September 2009 and was due for completion in March 2016, but in May 2016 it received an additional loan of 66 million Euro as indicated by data. In late 2018, CAB4 (phase 4) commenced, showing that the CAB project is is still underway.

From interviews, it is apparent that the country lacks the necessary skills to set regulations and establish guidelines to correct the mismanagement problem and promote governance when it comes to NCP. We did not succeed in our attempts to access the audit reports, which would reveal the compliance status of the project with respect to World Bank requirements.

5.5 The last mile

The last mile is the final component of the broadband infrastructure network. It connects end users (households, administrations, schools, hospitals, companies) to Internet through the telcos' networks. From data collected, it is noted that the country has now six established service providers (mobile operators and ISPs) that provide Internet services.

ISPs use the national backbone to connect to the undersea cable to provide Internet to end-users. Accordingly, data indicates that because the NCP is not running properly, it is improbable that the ISPs are efficiently connected to the WACS or CAB networks. As long as the NCP network is not completed and run properly the last mile network has limited usage or value, because NCP is a backbone of all last mile links.

5.6 Applications, services and content

The analytical framework indicates that applications, services and content are important components in the development of the broadband ecosystem. Once the infrastructure is set, it is important to provide services to end-users. Indeed, services and content are what is important to users, because they address their actual needs.

Additional data show that the country has poor local content, because of the lack of key services such as e-government and e-business, while services such as m-payment and e-learning are just in the infancy phase. As poor content and weak e-services characterise the current status of broadband development in Republic of the Congo, there is a need for proactive policy, new laws and strong regulation to encourage the development of e-services and e-content in Republic of the Congo.

5.7 Policy, law and regulation

As highlighted in the literature review and the analytical framework, policy, legislation and regulation play an important role in the development of the broadband ecosystem. In the previous chapter, we saw from data that the Republic of the Congo's policy in broadband is weak. The fact that no clear policy on broadband exists in the Republic of the Congo undermines the imminent overall development of its broadband ecosystem. Because of the 'vacuum' in broadband policy, the NCP has lost direction and the picture for the way forward is uncertain. As discussed earlier, actions need to be undertaken though the creation of policy, the review of the current sector law, and the push for appropriate regulations.

Table 5.1 Summary of broadband policies and their status

Policy	**Policy intention**	**Current state: Republic of the Congo**
National ICT Policy	Set ICT policy	Vision Congo Digital 2025 adopted
National broadband policy	Set national broadband policy	Only a digital economy policy exists
Spectrum policy	-	No such policy
Competition policy	-	No such policy
Taxation policy	-	No such policy

Data reveal that although the country has a digital economy policy, it contains no information on broadband. In other words, in Republic of the Congo broadband is not grounded in a given policy. As the literature review indicates, in the absence of broadband policy, regulation can be used to protect the market and foster competition. At the time of this study, the regulatory agency publishes regulations for the broad telecommunications market, some of which is relevant to broadband market development.

Table 5.2 Summary of broadband-related regulatory frameworks and their status

Regulatory intervention	**Intention**	**Current state: Republic of the Congo**
Establishment of regulatory authority	To have a regulatory organ which is legitimate	ARPCE has been established by the Law 10-2009
Evidence-based decision making (for example	For the regulator to set necessary guidelines to	Price regulation is in place

using regulatory impact assessment, or other tools)	advance competition in the broadband market and protect consumers	
Licensing framework	To set licensing regimes that ensure competition in markets, and facilitate growth	A license authorisation regime exists which allows any company that wants to enter broadband market to do so
Infrastructure sharing regulation	To guide conduct on infrastructure sharing	The regulation exists but is limited to towers
Spectrum regulation	To provide spectrum needed for broadband services	No spectrum regulation specific to broadband exists
Universal access and community connectivity to broadband	To advance universal access to broadband	The 2009 law created the relevant fund, the regulator has started discussing to project to be implemented

The lack of strong policy, laws, and extensive regulation for broadband has emerged as a major concern throughout this case study. As learnt from the literature, any project or program that is not based on a vision and strategy has a risk to lead to failure in the implementation phase. According to ITU (2018), the regulation of broadband is an increasingly important issue for two main reasons. Firstly, broadband provides the means to transport various signals (voice, data, video, etc.) that have traditionally been subject to differing regulation. Secondly, the infrastructure costs and first mover advantage in the provision of broadband services have great implications for competition. Competition is about increasing choice and efficiency to benefit consumers and make the economy more productive. In abuse of dominance cases, competition authorities define the relevant market in order to help determine whether there is a company holding a dominant position, and whether the conduct of such company produces anti-competitive effects. This is relevant to the continued review of competition in the 3G market in Congo, and the future 4G market.

Furthermore, because bottlenecks in electronic communications networks can be found at the wholesale level, it is considered that regulation should focus on ensuring access to bottleneck infrastructure in order to facilitate development of competition in downstream markets (OECD, 2014). Dominance limits regulatory intervention in markets where competition is ineffective, as such markets need some assistance that help smaller operators overcome the obstacles from strong dominant operators. In this respect, competition regulation with respect to opening up access to the NCP to ISPs appears to be required, so that Congo telecom does not continue this bottleneck.

5.8 Highlighting perspectives on key findings as the basis for recommendations

From study data, deeper insights arise which were not part of the initial problem statement, but which explain, in part, the situation of the development of the broadband ecosystem in Republic of the Congo. Below we outline some of these issues arising from the data, giving additional explanation to the initial discussion in the section above as the basis for presenting some ideas for the future.

5.8.1 Lack of direction in the broadband development process

At the time of this study, Republic of the Congo is running four government broadband projects, but they are not part of a government broadband projects portfolio. Instead there is a patchwork of "disconnected projects" set to achieve different goals. The general consensus among interviewees is that there is no coordination of the ongoing broadband projects. This indicates that there is no clear direction in the development of broadband although some broadband infrastructure is in place. Furthermore, there seems to be the lack of a body to bring together all the projects and create functional avenues among them. There is no collaborative framework between the teams or different projects. Hence, many broadband infrastructures overlap, and the opportunity costs in a number of them are simply too high, as the lack of coordination leads to wasted resources.

Although there has been an effort made by government to develop broadband, data reveal that the rationale for setting broadband project is not understood and the way forward remains unclear. This lack of direction in the broadband development process is expressed by the interviewees as one of the reasons that hinders the turnaround of the problems in the broadband development process and partly explains why each of the four broadband projects is run in different and independent ways.

5.8.2 The need for a new model for the management of broadband

Acknowledging the challenges to broadband development are very important. Congo telecom has shown its limitations in the management of broadband in Republic of the Congo. The way Congo telecom manages the WACS and NCP projects was revealed as one of the main causes for the difficult take-off in the development of broadband. Mismanagement, non-accountability and lack of planning skills calls for a new model of management. There is clearly a need for the placement of a new management team, alternatively of a company to manage broadband on behalf of government, in other words any change that will resolve the issues of organisation, management, operational, and strategic problems the country faces in relation to the development of the broadband infrastructure and ecosystem.

5.8.3 The need for skills for the ICT sector

Although the data findings do not clearly reveal it in a direct way, the lack of skills seems to be the root of many problems that undermine the development of broadband in Republic of the Congo. In particular, the lack of skilled policy analysts and designers is at the root of the lack of policy for broadband. Policy formulation and regulation setting require a high quality of up to date skills for both policy makers and regulators. Indeed, to formulate 'good' policies and issue appropriate regulations, the policy and regulatory professionals operating in the various institutions need to understand the broad electronic communications and ICT sectors in terms of technology, policy, legislation and regulation. The Direction Générale des Postes et des Télécommunications (DGPT), one department of the telecoms Ministry in charge of issuing or redrafting legislation for the ICT sector, does not have those appropriate skills to do its job. On the regulator side, there exists a small group of skilled people more cognisant with the aspects of regulation monitoring, while the development aspects of broadband is not well understood from what the researcher has seen. Hence, on the ground, there is no appropriate regulation issued that can foster competition in broadband markets, regulate spectrum and promote universal access for broadband.

Congo telecom, in its management of the two important broadband projects - WACS and NCP -, needs new skills to understand technology, broadband and project management, in order to champion the development of broadband in the country. Many interviewees said that the reason for most of the operators' distrust of Congo telecom is the lack of skills. Skills in the ICT sector are important to sustain the development of broadband and serve to underpin the dynamic nature of the development of the broadband ecosystem. Skills in technology, policy, law and regulation are necessary in the creation of an appropriate environment for more effective development of broadband. In the literature, skills are recognised as a major catalyser in any circumstances, including in broadband technology adoption, regulation and policy (Majumdar, 2008). There has been an appeal from informed individuals and accordingly there is a call for the government, regulators and Congo telecom to build capacities so that skilled people can participate in the development of broadband.

5.9 Conclusion: Summary of problems and challenges

Despite the reality of WACS in Republic of the Congo, problems exist. We selected some key problems that can be partly addressed through policy and regulatory action, namely:

- Lack of direction in the broadband development process
- Deficient regulatory environment for broadband

- The need for a new model of management to address technical mismanagement and other management issues in broadband infrastructure, including deficient infrastructure service capability
  The need for professional skills for electronic communications and ICT-related policy and regulation

The purpose of this chapter has been to discuss findings that emerge from discussions in the previous chapter, and assess the results in relation to the literature review, the analytical framework and the main research question. Principal concerns are noted in the lack of appropriate and strong policy and regulatory framework on broadband. This strongly undermines the development of the broadband ecosystem in Republic of the Congo.

Chapter Six: Proper policy and regulation for an efficient development of broadband

6.1 Introduction

The main research question in this study is aimed at understanding how policy and regulation can address the challenges of broadband development in the Republic of the Congo. The three sub-questions are:
(1) How has policy and regulation affected the development of the broadband ecosystem in Republic of the Congo?
(2) What are the main challenges that hinder the development of the broadband ecosystem in Republic of the Congo in general and more specifically the national backbone project (the NCP)?
(3) What key policy and regulatory interventions are required for an effective development of the broadband ecosystem?

With respect to sub-question 1, findings from chapter 4 point to the lack of appropriate policy, and the weaknesses in regulation as main or root causes for the deficient performance in the development of broadband. Although a regulator exists, its actions seem to be unproductive. Although the regulator's actions have an impact on the electronic communications sector in general, its effect on broadband development is not currently visible. A proper regulatory process is needed for people to draw the benefits that broadband can bring to the country in terms of job creation, economic growth and welfare. The literature indicates the necessity for know-how and skills for electronic communications and ICT sector policy and regulation. Yet, data reveal the lack of requisite skills along the overall broadband management chain, including the telecoms Ministry, the regulator, Congo telecom (operator), and consumers. Consumers for example are misinformed on what is going on in the market, and are then unable to make proper choices. It is therefore urgent for each structure to build capacities for policy formulation and regulation.

With respect to sub-question 2, threats that undermine the long term development of broadband in the Republic of the Congo include the mismanagement practices of the public telecom operator in relation to the NCP project, unreliable governance, and the deficiency of requisite skills for effective operation of the broadband ecosystem. As a result, the Republic of the Congo broadband ecosystem is left wanting in its development. few conclusions are noted. NCP is seen as a critical bottleneck in the development of the broadband infrastructure in the Republic of the Congo. Although WACS is complete from an international standpoint, there remains the need for further action at the national level along with the development of strong management and policymaking skills. Correspondingly, interview participants expressed serious concerns with respect to Congo telecom's role, in particular the lack of transparency, poor governance and accountability, and poor management of

the NCP, which negatively affect the development of broadband. There is a need for placing a new company in charge of the management of broadband. A focus needs to be put on formulation of polices and regulations, as they are key drivers for the efficient development of the broadband ecosystem, for the benefit of citizens.

With respect to sub-question 3, a number of recommendations are listed in the section below, derived from the data analysis, as it emerges that the development of broadband needs to be fuelled in many respects (policy, law, regulation, management and capacity) to have effective future development of the broadband ecosystem in the Republic of the Congo. The analytical framework indicates that infrastructure, services, policy and regulation should be strongly embedded. The analysis provided by the researcher, in the context of the analytical framework, called for the research to make the following recommendations to various stakeholders in the electronic communications sector.

6.2 Recommendations

It is imperative that the government, the regulator and partners involved in the development of broadband (mainly the World Bank and the African Development Bank) ensure that the following recommendations are taken into consideration for greater success in broadband implementation.

6.2.1 Recommendations relevant to policy

6.2.1.1 Set a national policy and strategy specific to fostering broadband markets

Public policy is foundational in any development process. Thus, a country must design a broadband policy which set goals the government intends to achieve for the benefit of the majority citizens. In other words, it is a risk to start implementing broadband projects without proper policy in place. Although the development of broadband is already underway in Congo, the one policy in place is for digital economic development, while the other is for universal access and services. The concern with the digital economy policy is that it is a broader policy, rather than a focused one. The universal access policy does not focus on all the elements of the broadband ecosystem. The researcher recommends that the government set a specific national broadband policy that indicates the direction and guidance for the acceleration of broadband development in the Republic of the Congo.

The Ministry of Posts, Telecommunications and Digital Economy should formulate a policy on broadband. With a proper and specific policy on broadband, particularly people who live in remote areas of the country will have affordable access to broadband related applications and services, and thus benefits from opportunities offered by the information society.

6.2.1.2 Set competition policy to attract investments for broadband

Competition policy is need to make sure companies compete fairly; it helps to reduce prices and improve quality. Some countries have general competition policies, others have set sector competition policies. In the absence of general competition policy, the government could initiate a competition policy with respect to broadband markets, in order to promote economic welfare for all stakeholders.

6.2.1.3 Improve the current digital economic development policy

The main weakness of the current digital economic development policy is that it does not set goals, nor a timeframe to achieve them. Another problem with that policy is that no strategic plan yet exists associated with the policy. The country would gain to request relevant expertise to properly reformulate the policy and establish a plan that will indicate how to manage in order to achieve the vision of the government when it comes to the development of broadband in the country.

6.2.1.4 Continuously review the universal access policy for broadband

The current sector law deals with universal access matters, and establishes the universal access fund. The law (09-2009) says that the government will set the universal access policy to be implemented by the regulator. The MPTEN (telecoms Ministry) has formulated the universal service and access policy, adopted in 2019, which is a starting point for the expansion of broadband network and services to underserved populations throughout the country. This will require regular review and updating at least every two years in the immediate future.

6.2.2 Recommendations relevant to regulation

6.2.2.1 Strengthen the regulatory framework

There is a need for an enabling regulatory environment that promotes competition, improves access, pushes forward the delivery of services, and promotes quality of service standards and affordable retail prices. Indeed, once policy is formulated the regulation is necessary to create the relevant rules of the game for players in the market including operators and consumers. In fact, regulation stands as a link between policy and service delivery.

To fill the existing gap in terms of broadband regulation in Congo, the research recommends the design and implementation of the following broadband regulations: undersea cable, backhaul, price (wholesale and retail), spectrum, infrastructure sharing, and rights of way.

6.2.2.2 Price and taxation regulations for broadband

Price is a key component of competition regulation. As in other fields, in the telecoms sector, price is mainly derived from costs of producing a given service. In Congo, since 2011 the regulator benefits from external assistance to calculate costs of 'classic' telecoms services such SMS, off net and on net calls. The research recommends that the regulator should extend the calculation of costs and tariffs to broadband capacities in the wholesale market and broadband services in the retail market.

6.2.2.3 Infrastructure sharing regulations for broadband

While the infrastructure sharing regulation is in place in the Republic of the Congo, it is limited to towers and power equipment shared between the owner operator and others. The researcher makes a recommendation to the regulator to extend the infrastructure sharing regulation to concrete culvert infrastructures. Actually, culverts built through towns are owned by Congo telecoms (the incumbent fixed operator). The culvert is recognised as a critical infrastructure, so not easily replicable due to the high costs. The regulator should recognise concrete culverts as such and proceed to its regulation. This will be benefit competition in the broadband wholesale and retail market, as it would lead to lowering operational costs of delivering broadband services.

6.2.3 Other recommendations

6.2.3.1 The completion of the NCP project

In Congo, the broadband network is composed of three main infrastructure network projects: WACS (the undersea cable network), CAB (the interconnection with border countries' networks) and NCP (the land national backbone). NCP is the core network as it aggregates other networks including those of diverse operators. Findings show that the NCP is not completed yet and this is a very critical situation. Without the NCP network it is not possible for data to flow from the WACS network for example to the CAB one, or from any one geographic point in the country to another.

The researcher strongly recommends that government, as an ultimate priority, evaluates the NCP project, and finds the way to complete the project. Without NCP project completion, it will not be possible for the country to successfully complete the roll out of broadband, and all efforts including resources put into the broadband project will not really benefit the country as it should.

6.2.3.2 For financial partners to redirect the CAB project funding to NCP

Funding is important for the success of projects. Most of the time financial partners bring fund to help a country designing and implementing projects. In the Republic of the Congo, the World Bank and the African Development Bank funded the CAB project, while the Chinese cooperation funded the NCP project. Data revealed that between 2009 and 2016 the CAB project received significant funding. Despite the fact

that the CAB project was not completed in 2016 and started showing failure, the African Development Bank decided to provide additional funds. Findings show two problems: Firstly, the CAB has received a large amount of funding, but still failed to be completed. Secondly, even if it is completed, it will be of no value unless the NCP network is completed and operational.

It is recommended that the African Development Bank redirects the funding provided for the development of broadband to the NCP project, instead of continued funding for CAB. Funding of the NCP project should be conditional on independent and effective project management, and proven skills and expertise.

6.2.3.3 Incentives: Development and use of local content

Even when the broadband infrastructure is in place, it is important to motivate people to use the network. As learnt from the literature, the demand for broadband is driven by the demand for content. Broadband content constitutes an important component of the broadband ecosystem, as shown in the analytical framework. The lack of content, including local content has been pointed out by findings as a problem that needs to be corrected. Indeed, it is only with innovative content that people would value broadband and use it more and more. The government should put in place, mechanisms that encourage government departments and companies, including start-ups, to develop content that will drive the use of broadband in the country. These could be in several fields including education, health, culture, finance.

6.2.3.4 Relevant proficiencies of the broadband development process

Proficiency is important in any business. With the lack of relevant skills, any development process has the risk of to getting into trouble. Findings of this case study reveal the lack of proficiencies to be one of the main causes that undermines the development of broadband in the Republic of the Congo. The researcher comes to the conclusion that there is an urgent need to build capacities, in all fields involved in the development of broadband, including law, economics, management, leadership, policy, regulation, and governance. Skilled people would be able to make useful inputs, and intervene in the development of the broadband ecosystem in the Republic of the Congo.

6.2.3.5 To proceed to the review of the ICT sector law

The current ICT law dates back to 2009, which is now out of date. Furthermore, it does not accommodate changes in the field such as technology convergence, broadband development, cyber attacks, and the emerging new applications and services. The recommendation is that the MPTEN design a new sector law.

6.3 Conclusion

Broadband has been demonstrated to be an enabler of growth. In this regard many countries, including the developing ones, have chosen to focus on the development of broadband in order to bridge the digital divide, and enable people to participate in the knowledge and information society. The development of broadband depends not only on the infrastructure roll out (fibre optic cable, equipment, technology and applications), but also on policy and regulation. This is the way for the Republic of the Congo to go. As outlined in this case study, broadband has a positive impact on all fields of life including education, health, administration, trade, employment, and government. However, for this to happen in the Republic of the Congo, the study has shown that policy and regulation are important levers the government and policy makers can use to enable broadband development, so that citizens enjoy broadband services, and really participate in the knowledge and information society.

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Appendix A: Interview guide.

Assessment of the development of the broadband ecosystem in Republic of the Congo

There are 5 categories of data required divided with a total of 10 questions dealing with all of the different components of the broadband ecosystem.

Section A: Undersea cable
Section B: National backbone
Section C: Access network (last mile)
Section D: Applications and e-services
Section E: Policy and regulation

Section A: Undersea cable
1- Now that the Republic of the Congo is connected to the undersea-cable (WACS project), what are your main expectations as far as the regulation of the undersea-cable is concern?

2 – What had been, if any, the impact of policy in creating conditions for an effective competition at the undersea-cable's facilities?

Section B: National backbone
3 - Please describe the challenges in building the broadband infrastructure?

4-While the development of broadband is underway in the country, what services / applications do you think will be most useful for users

Section C: Access network (last mile)
5 - Congo telecom (the owner the national backbone) and MTN-CG have significant power on the backbone market (as WACs shareholders). What do you think might be done to promote and maintain competition on the last mile (retail broadband market)?

6 - Please describe how broadband should be delivered to houses, including in the remote areas?

Section D: Applications and e-services
7 - Please explain how local e-services content is being developed?

8 - What social or economic value does broadband create in Republic of the Congo?

Section E: Policy and regulation

9 - The latest ICT sector law (The 2009 Act) does not deal with the broadband issues. What regulations are required for an effective development of the broadband band.

10 - What must be done by the government in terms of policy so that people can draw the maximum benefit of broadband in Republic of the Congo.