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Effect of Network Infrastructure Sharing on Cost Reduction of Network Infrastructure Rollout and Capacity Expansions for Telecoms Operators in Benue State

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Abstract – *With the high demand for quality service by telecom users, combined with the heated competition of a gradually maturing telecom market in Nigeria, some telecom operators are led to explore ways of reaching their potential customers in a very cost efficient and cost effective way. The main objective of this study is to find out if network infrastructure sharing results in a significant reduction in cost of network infrastructure rollout and capacity expansions for telecoms operators in Benue State. The study respondents consists of senior technical, rollout managers, finance/accountant and adminstrative staff cadre of MTN and GLO working in Benue State. The population of this category of staff in GLO is 120, while MTN is 170, making a total of 290 respondents. The sample size is 168. Multiple-Regression is a multivariate statistical technique was employed to predict the established relationships between the variables. The study fond out that that network infrastructure sharing leads to significant reduction in cost of network infrastructure rollout in the rural areas for telecoms operators in Benue State. Network infrastructure sharing eliminates some setup costs such as land acquisition cost, civil works cost, and tower construction cost as well as long and tedious bureaucratic processes of seeking permits. This helps in rapid rollout to new areas while drastically reducing cost of network expansion cost by over 50 per cent. This helps in improvement on time to market. Network infrastructure sharing reduces operational costs such as electricity and security among others leading to operational efficiency. Rural infrastructure sharing is strongly recommended (both 2G and 3G) in Benue State because majority of the population are living in rural areas. The main recommendation is in respect of the epilepsy power supply. It is recommended to the Federal Government to speed up its power sector reforms, as doing so will bring great relief to the infrastructure sharing in Benue State. The tariffs charged by the telecom operators for their services will be drastically reduced and quality of services provided by the operators will also improve tremendously.*

Keywords: *Capacity Expansions, cost reduction, Infrastructure rollout, network infrastructure sharing*

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1. Introduction

Nigeria recognized the need for efficient and reliable telecommunication services and subsequently deregulated the telecoms industry in 1990 in order to enhance economic advancement. Currently, there are four mobile telecom operators in Nigeria, namely, MTN, Glo, Airtel and Etisalat. Incidentally all of them are either wholly or largely owned by foreign multi-national telecom companies except Glo. As at September 2014, MTN is the largest operator in the mobile sector having 56.5 million subscribers, Glo 27.3 million subscribers, Airtel 25.3 million subscribers and Etisalat 19.4 million subscribers (Nigerian Communications Commission, 2014). Glo retained its position as the network with the second largest internet subscription in the country with 14.3 million active subscriptions. MTN is in the first place with 34 million, while Airtel and Etisalat have 12 million and 6.8 million active internet subscriptions respectively (Nigerian Communications Commission, 2014).

With the high demand for quality service by telecom users, combined with the heated competition of a gradually maturing telecom market in Nigeria, some telecom operators are led to explore ways of reaching their potential customers in a very cost efficient and cost effective way. Co-location is one of them and it is expected that this will reduce the cost of rolling out telecom infrastructure while at the same time achieving the numbers through effective network coverage.

The two selected network operators (MTN and Glo) are the most dominant service providers in the State because of their availability in the grassroots, widespread coverage and preferred networks. Three local governments (Makurdi, Otukpo and Katsina-Ala) in each of the three senatorial districts of the State were selected for the study because they are the centre/hub of economic activities in the State. The three senatorial districts are: i) Benue North East comprises of Katsina-Ala, Konshisha, Kwande, Logo, Ukum, Ushongo and Vandeikya. ii) Benue North West comprises of Makurdi, Gboko, Buruku, Guma, Gwer East, Gwer West and Tarka. iii) Benue South comprises of Otukpo, Ado, Agatu, Apa, Obi, Ogbadibo, Ohimini, Oju, and Okpokwu.

The main objective of this study is to find out if network infrastructure sharing results in a significant reduction in cost of network infrastructure rollout and capacity expansions for telecoms operators in Benue State. The study addresses the following research question: To what extent has the telecommunication infrastructure sharing led to cost optimization and revenue generation in Benue State? Statement of the null Hypothesis (H_0) is: Network infrastructure sharing does not result in a significant reduction in cost of network infrastructure rollout and capacity expansions for telecoms operators in Benue State.

2. Literature Review

2.1.Theoretical Framework

2.1.1.The Resource Based Theory of infrastructure sharing

The resource based view is a theory that examines the relation between a firm's internal characteristics and performance. Using this theory, the potential of firm resources to generate sustained competitive advantage is analyzed. It is based on the assumption that strategic resources are heterogeneously distributed across the firms (heterogeneous) and this distribution is stable over time (immobile). Barney (1991), specifies the conditions under which strategically relevant resources can be sources of sustained competitive advantage for a firm. The firm resources that are considered are the physical capital resources, the human capital resources and the organizational capital resources (Barney, 1991). In order for a firm's resource to generate sustained competitive advantage, the resource should be valuable, rare, inimitable and non-substitutable.

2.1.2. Business Models and Network Operators Theory

According to Bouwman, Haaker and De Vos (2008), a business model is a blueprint for a service to be delivered, describing the service definition and the intended value for the target group, the sources of revenue, and providing an architecture for the service delivery, including a description of the resources required, and the organizational and financial arrangement between the involved business actors, including a description of their roles and the division of costs and revenues over the business actors.

Four different domains constitute the components of a business model according to Bouwman, Haaker and De Vos, (2008). Specifically, the service, technology, organization and finance domain are the main components of a business model. If these components are specified then the business model is also specified. Osterwalder and Pingeur (2004) describe a tool named business model canvas that can be used for designing successful business models. There are nine building blocks that should be defined so as to define a business model. The customer segment, the value proposition, the channels, the revenue streams, the customer relationships, the key resources, the key activities, the key partnerships and the cost structure are the nine building blocks.

2.2. Conceptual Framework

i. Passive Infrastructure Sharing (Site Sharing)

This is the sharing of the non-electrocnic infrastructure at the cell site. It is also known as Site Sharing and in this form of sharing, operators agree to share available infrastructure such as site space, buildings and easements, towers and masts, power supply and transmission equipment (Chanab, El-Darwich, Hasbani and Mourad, 2007). This kind of sharing is suitable for densely populated areas with limited availability; expensive sites such as underground subway tunnels and rural areas with high transmission and power costs.

The key challenges in this model are for incumbent operators to accept the opening of the infrastructure to other players and for new operators to trust that incumbents will provide them with the appropriate access to sites without tactical delays to prevent them from rolling out thier networks effectivley (Chanab, El-Darwich, Hasbani and Mourad, 2007). Enforcing such cooperation is a major challenge to regulatory authorities.

It is sharing non-electronic infrastructure at cell site. Passive Infrastructure is becoming popular in telecom industry worldwide. An example of this is base station sharing where each operator maintains control over electronic components so that it will be able to operate the frequencies assigned to the carrier, fully independent from the partner operator and retains control over their respective active base station equipment such as the transceivers that control reception/transmission over radio channels. Radio network controller and core network are not shared here (Håkansson and Snehota, 1995).

ii. Active Infrastrcuture Sharing (Network Sharing)

This form of infrastrcuture sharing entails the operators sharing the electronic infrastrcuture such as sharing base station controllers (BSC), and sharing common networks, both circuit-switched and packet-oriented domains (Chanab, El-Darwich, Hasbani and Mourad, 2007). Network sharing (active sharing) requires additional planning and deployment efforts to accomodate each participating operator's capacity needs (Chanab, El-Darwich, Hasbani and Mourad, 2007).

Active sharing involves the shared use of electronic infrastructure in a cell site, including the base tower station, switches, antennas, transmission, signal processing transceivers and microwave radio equipment. In other words, single radio equipment can be shared across different frequencies, by different operators to deploy a completely shared radio network and in some case, a partly shared Core Network (i.e. Back bone network). The shared radio network consists of Radio Base Stations, Radio Network Controllers, transmission site etc. Active sharing is not allowed by regulation in most of countries and has to be initiated amongst the operators themselves.

An example of active sharing is spectrum-sharing concept which is based on a lease model and is often termed spectrum trading. An operator can lease a part of their spectrum to another operator on commercial terms. This mechanism exists in the US, Europe, Singapore, India and Australia (International Telecommunication Union, 2004). Passive infrastructure is estimated to reduce deployment costs by 60 percent and active infrastructure by 40 percent (Barney and Arikan, 2001). It is the height of a telecom tower that determines the number of antennas that can be accommodated (i.e. the capacity of the tower). Others factors such as location and geographical conditions (wind speeds, type of terrain, etc.) can also play a part in determining the capacity of the tower. Hence, typically, while Ground Based Towers can accommodate up to six tenants, Roof-Top Towers can accommodate two to three tenants.

iii. Spectrum Sharing

This concept, also known as spectrum trading , is a model that has recently developed in mature, regulated environment and it entails an operator leasing part of its spectrum to another operator on commercial terms. Since spectrum is a scarce that is often under-utilized by one operator in a given location, sharing proves a viable option for two or more operators (Chanab, El-Darwich, Hasbani and Mourad, 2007).

iv. National Roaming (Geographical Splitting)

Mandatory national roaming is a form of infrastructure sharing that allows new operators, while thier networks are still being deployed, to provide national service coverage by means of sharing incumbents' networks in specific areas (Oliver, 2007). While national roaming is generally introduced with a sunset clause, it could be made permanent in specific locations. National roaming accelarates competition by allowing new players to launch their services within shorter time frames (Chanab, El-Darwich, Hasbani and Mourad, 2007).

v. Tower Companies

The growth of existing tower management companies have also helped to ease out problems of infrastructure. The business model consists of acquiring wireless infrastrcuture for operators and managing it (Park and Russo, 1996). The economics are strongly driven by colocation of operators on sites. Tower management comapnies usually enjoy scalable and long-term recurring revenues with contracted annual escalations. They also benefit from low churn rates and low operating and capital costs. Tower management companies thus can ensure fair treatment of new entrants while providing financial benefits to the incumbents by buying the latter's infrastrcuture and managing it, hence lowering operating expenses in the long run (Chanab, El-Darwich, Hasbani and Mourad, 2007). An example of this is Helio Towers Nigeria, Huawe, Alcatel, the company that provide wireless operators in Nigeria with fully-managed tower sites on a lease basis.

3. Methodology

3.1. Research Design

This study uses a combination of descriptive, correlation and cross sectional type of research. The descriptive aspect refers to that objective of systematically describing the concept of infrastructure sharing and the possible benefits that can be derived from it. The correlation aspect refers to that objective of discovering or establishing the existence of a relationship/ interdependence between two or more variables relating to telecommunication infrastructure sharing such as extent of indulgence vis a vis cost savings. The cross sectional aspect refers to observation of sample subjects done at different points in a short period of time.

3.2. Population and Sampling Procedure

The mobile GSM sector is made up of four (4) operators (MTN, Glo, Airtel and Etisalat) of which the researcher considers co-location relationship mainly between two (2) dominant operators (i.e. Glo and MTN) because the operators have wider coverage and were preferred by subscribers in Benue State. In this study, the researcher developed a well-structured and standardized questionnaire on perceived aspect of co-location that affect cost efficiency of GSM firms in Benue State based on the Likert five-point ordinal scale and they were administered to senior technical, rollout managers, finance/accountant and management staff in the domain of study. The respondents possess technical skills, academic qualification and experience in co-location arrangement of GSM operations in Benue State.

Hence, this study respondents consists of senior technical, rollout managers, finance/accountant and adminstrative staff cadre of MTN and GLO working in Benue State. The population of this category of staff mentioned above in GLO is 120, while MTN is 170, making a total of 290 respondents.

A sample size is the number of elements selected from the population which is representative of that population (i.e. a sample must be a representative of the whole population). A representative sample size with known confidence and risk levels was selected based on the work of Yamane (1967). The rationale for choosing Yamane is that the sample size is more than 100 respondents.

An appropriate response rate was determined. The formula used by Yamane (1967) is shown below.

Formula for population proportion:

$$\boldsymbol{n_0} = \frac{z^2 P(1-P)N}{z^2 P(1-P)+Ne} \text{.......................... (1)}$$

Where:

n_o = sample size

z = confidence interval corresponding to a level of confidence

p = population proportion

N = population size

e = precision or error limit

The Yamane formula assumes a normal distribution. The formula could therefore be considered suitable for determining an appropriate sample size. The study population is 290 (i.e. N=290). Applying the Yamane technique gave a sample size of 168. A 95% confidence level was deemed acceptable and thus statistically, z = 2. The proportion of responses that would be relevant to the survey is population proportion (p). If p is 0.5. The method of arrival at this sample size is indicated below (Yamane formula):

$$\boldsymbol{n} = \frac{\boldsymbol{N}}{\boldsymbol{1} + \boldsymbol{N}(\boldsymbol{e})^2}$$

Where: n = required responses/sample size, e^2 = error limit, N = population size

Placing information in the formula at 95% confidence level and an error limit of 5% result in:

$$n = \frac{290}{1+290(0.05)^2}$$

$$n = 168$$

Thus, 168 respondents were adequate for the study. This gave a 95 percent, confidence level and potential error limits of 0.05 (5 percent) was found in the field. To assign/allocate the sample size of 168 to both staff of Glo and MTN, the researcher employed the Bourley's proportional allocation formula:

$$\boldsymbol{n_b} = \frac{\mathbf{n}(\boldsymbol{h})}{\mathbf{N}}$$

Where:
n_b = Bourley formula
h = Element within the sample frame. i.e. number allocated to each Glo and MTN employees
n = Sample or proportion of the universe used for the study (total sample size)

N = Population of the study.

Glo Staff: $\mathbf{n_b} = \frac{\mathbf{120 \ x \ 168}}{\mathbf{290}}$

$= \frac{20,160}{290}$

$= 69.5$

$= 70$

MTN Staff: $\mathbf{n_b} = \frac{\mathbf{170 \ x \ 168}}{\mathbf{290}}$

$= \frac{28,560}{290}$

$= 98.4$

$= \underline{98}$

To cross check:

70 + 98 = 168 (Sample size).

3.3. Model specification

The evaluation of relationship between dependent and independent variables was carried out using the multiple regression models. The first step consisted of defining the variables of the study. This was to determine the relationship between the combined explanatory variables and cost incurred. The cost optimisation (CO) in this study is the dependent variable and the telecommunication infrastructure sharing is the independent variables represented by (TIS).

In this study, cost optimisation was regressed and correlated on the set of explanatory variable of telecommunication infrastructure sharing. The coefficients of the variables measure directly or indirectly the marginal effects of the independent variables on cost optimisation in the study area.

The most general form for the model is:

CO = f(TIS, b) .... (i)

where,

CO: the dependent variable is a measure of cost optimisation;
f: a function to be specified;
TIS: explanatory variables of telecommunication infrastructure sharing;
b: variables measuring the explanatory variables (parameters)

In specific form, equation (i) translates into equation (ii)

$$CO = a + b_1TIS_1 + b_2TIS_2 + b_3TIS_3 + ..., + b_nTIS_n + e \quad .... \quad (ii)$$

where,

CO = dependent variable (cost optimisation)

a = constant

TIS_1, TIS_2, TIS_3, ..., ..., ..., ..., ..., TIS_n are independent variables (infrastructure sharing - micro wave radio equipment, shelters, switches, electric supply. Antennas, easements, transreverts and ducts).

b_1, b_2, b_3, ..., ..., ..., ..., ..., b_n are the regression coefficients which determines the contribution of the independent variables.

e = residual or stochastic error (which reveals the strength of bx_1 ... b_nx_n; if e is low the amount of unexplained factors will be low and vice versa.

The multiple regression analysis is relevant to this study as it assists in predicting, making inferences, testing the set hypotheses, and modeling the relationships between the variables.

3.4. Data Analysis Techniques

The researcher provides an exposition on the methods used to measure and analyze data for each study objectives and hypotheses. Multiple-Regression is a multivariate statistical technique which helps to predict one variable from other variables, as long as there are established relationships between the variables (Nworuh, 2004). The variable being predicted is usually known as dependent variables because its values are dependent on the other variables referred to as the independent variables.

4. Results and Discussion

4.1. Presentation and Analysis of Data

4.1.1. Network infrastructure components sharing

i. **Microwave radio equipment:** Majority of the respondents (42.7%) were neutral that their GSM companies help to reduce cost on customers by sharing their microwave. A large percentage, 18.3%, of the respondents agreed to this fact, while 15.9% did not agreed at all. A lesser percentage (13.4%) of the respondents strongly agreed, while, an uninspiring percentage (9.8%) strongly disagreed. The weighted average for this group was 2.13.

ii. **Your Shelters are very important in reducing operational expenditure:** Most of the respondents (37.8%) were neutral that shelters are very important in reducing operational expenditure. A large percentage of 20.7% of the respondents agreed to this fact, while 18.3% did not agree at all. A lesser percentage (15.9%) of the respondents strongly agreed, while, an uninspiring percentage (7.3%) strongly disagreed. The weighted average for this group was 2.30.

iii. **You have sufficient switches:** Majority of the respondents (34.1%) is neutral that their GSM companies have sufficient switches. A large percentage of 22.0% of the respondents agreed to this fact, while 18.3% strongly agreed. A lesser percentage (13.4%) of the respondents strongly disagreed, while, an uninspiring percentage (12.2%) disagreed. The weighted average for this group is 2.30.

iv. **Electric supply:** Majority of the respondents (37.8%) were neutral that there is efficient electric supply. A large percentage of 22.0% of the respondents disagreed to this fact, while 15.9% strongly disagreed. A lesser percentage (17.1%) of the respondents agreed, while, an uninspiring percentage (7.3%) strongly agreed.

v. **Your antennas are reliable in hosting other GSM networks equipment:** Majority of the respondents (43.9%) were neutral that their GSM companies have reliable antennas for hosting competitors. A large percentage of 18.3% of the respondents disagreed to this fact. Two sets of respondents to a certain percentage (12.2%) both strongly agreed and agreed to this fact, while an uninspiring percentage (13.4%) strongly disagreed. The weighted average for this group was 2.10.

vi. **You have reliable easements:** Most of the respondents (29.3%) were neutral that their GSM companies have reliable easements for sharing. A large percentage of 23.3% of the respondents disagreed to this fact, while 19.5% strongly disagreed. A lesser percentage (17.1%) of the respondents agreed, while, an uninspiring percentage (11.0%) strongly agreed. The weighted average for this group was 1.99.

vii. **Your transreverts are relevant for improving quality of service:** Most of the respondents (25.6%) were neutral that their GSM companies have relevant transreverts for improving quality of service. A large percentage of 26.8% of the respondents disagreed to this fact, while 19.5% strongly disagreed. A lesser percentage (15.9%) of the respondents agreed, while, a lesser percentage (12.2%) of the respondents agreed. The weighted average for this group was 1.97.

viii. **Your ducts are better than other GSM networks:** Most of the respondents (34.1%) were neutral that their companies often make promises to potential customers through advertisement. A considerable percentage (22.0%) of the respondents agreed to this fact, while 18.3% strongly agreed. A lesser percentage (13.4%) of the respondents strongly disagreed, while, an uninspiring percentage (12.2%) disagreed. The weighted average for this group was 2.30.

4.1.2. Cost optimization strategy

i. **Network infrastructure components sharing aids cost reduction for your customers:** Majority of the respondents (26.8%) disagreed that a network infrastructure components sharing aids cost reduction for customers. Considerable percentages (25.6%) of the respondents are neutral to this fact, while 19.5% strongly disagreed. A lesser percentage (15.9%) of the respondents agreed, while, an uninspiring percentage (12.2%) strongly agreed. The weighted average for this group was 1.97.

Table 1: Summary of Data Presentation

S/N	Statement	SA	A	N	D	SD	Weighted Average
(I)	**Network Infrastructure Components Sharing**	5	4	3	2	1	
(i)	Your microwave radio equipment helps in reducing the cost on customers	22 (13.4)	30 (18.3)	70 (42.7)	26 (15.9)	16 (9.8)	2.13
(ii)	Your shelters are very important in reducing operations expenditure	26 (15.9)	34 (20.7)	62 (37.8)	30 (18.3)	12 (7.3)	2.30
(iii)	You have efficient switches	30 (18.3)	36 (22.0)	56 (34.1)	20 (12.2)	22 (13.4)	2.30
(iv)	Efficient electric supply	6 (7.3)	14 (17.1)	31 (37.8)	18 (22.0)	13 (15.9)	2.00
(v)	Your antennas are reliable in hosting other GSM network's equipment	20 (12.2)	20 (12.2)	72 (43.9)	30 (18.3)	22 (13.4)	2.10
(vi)	You have reliable easements	18 (11.0)	28 (17.1)	48 (29.3)	38 (23.2)	32 (19.5)	1.99
(vii)	Your transreverts are relevant for improving quality of service	20 (12.2)	26 (15.9)	42 (25.6)	44 (26.8)	32 (19.5)	1.97
(viii)	Your ducts are better than the other GSM networks	30 (18.3)	32 (22.0)	56 (34.1)	20 (12.2)	22 (13.4)	2.30
(II)	**Cost optimization strategy**	5	4	3	2	1	
(i)	Network infrastructure components sharing aids cost reduction for your customers	20 (12.2)	26 (15.9)	42 (25.6)	44 (26.8)	32 (19.5)	1.97

Source: Field survey, 2014

Note: values in parenthesis are in percentages, 5 = Strongly Agreed [SA], 4 = Agreed [A], 3 =Neutral [N], 2 = Disagree [D], 1 = Strongly Disagree

4.2. Test of Hypothesis (H_0)

The t-calculated values: 3.541, 2.715, 5.370, 2.351, 2.571, 3.693, 2.430 and 3.804 for microwave radio equipment, shelters, switches, electric supply, antennas, easements, transreverts and ducts respectively showed significant values, because they were greater than the t-tabulated value (1.98) (see Table 2). The F-calculated value was 46.382, which is greater than the F-tabulated value of 2.00. However, the (n-k, k-1), where, n=the sample size, k=the number of variables in the regression model. Thus (164-9, 9-1) = (156, 8), at a 5% significant level. The null hypothesis was rejected while the alternative hypothesis (**H_1**) was accepted, which states that, *"network infrastructure sharing results in a significant reduction in cost of network infrastructure rollout and capacity expansions for telecoms operators in Benue State."*

Table 2: Network Infrastructure Sharing and Cost of Network Infrastructure Rollout and Capacity Expansions for Telecoms Operators in Benue State.

Coefficients[a]

Model 1	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	0.129	0.246		0.522	0.603
Microwave radio	0.239	0.067	0.278	3.541*	0.001
Shelters	0.195	0.076	0.207	2.715*	0.012
Switches	0.419	0.078	0.443	5.370*	0.000
Electrical supply	0.131	0.056	0.145	2.351*	0.021
Antennas	0.148	0.045	0.183	2.578*	0.000
Easements	0.274	0.054	0.293	3.693*	0.000
Transreverts	0.181	0.082	0.124	2.430*	0.018
Ducts	0.284	0.058	0.317	3.804*	0.000

a. Dependent Variable: cost of network infrastructure rollout and capacity expansions, *Correlation is significant at the 0.05 level (2-tailed), F-Calculated value = 46.382, R = 0.831, R^2 = 0.691.

Source: SPSS print out 2014

4.3. Discussion of Findings

The multiple co-efficient of correlation (R) was 0.831; meaning that there was a strong relationship between the variables of Model 1 (see Table 2). The multiple coefficient of determination (R^2) on the other hand was 0.691 indicating that 69% of cost of network infrastructure rollout and capacity expansions was caused by variation of microwave radio equipment, shelters, switches, electric supply, antennas, easements, transreverts and ducts. Thus, we concluded that network infrastructure components sharing; influence the cost of network infrastructure rollout and capacity expansions.

A major area of techno-economic evaluation is the modeling and analysis of networks, demand, costs and revenues technology rollout, cost structure, service classification combined with demand, pricing and revenue forecasts. The network costs are estimated as a function of the user demand levels and geographical distribution.

Ballon (2007) and Braccini (2008) provide useful overviews of business model contributions for telecom markets and services. In Braccini (2008), the Business Model Ontology (BMO) by Osterwalder (2005) and the e3-Value Ontology by Gordijn and Tan (2005) are described. The BMO was introduced in order to systematize and summarize all definitions and the contributions related to business model research available in literature. According to the BMO, a business model should express the business logic of a specific firm describing the value a company offers to one or several segments of customers and of the architecture of the firm and its network of partners for creating, marketing, and delivering this value and relationship capital, to generate profitable and sustainable revenue streams. The BMO is composed of four main elements or pillars: Product, Customer Interface, Infrastructure Management and Financial Aspects.

The e3-value methodology Gordijn and Akkermans (2001) has been developed to model a value web consisting of actors who create, exchange, and consume things of economic value. The e3-Value Ontology aims at identifying exchanges of value objects among actors in a business case and supports profitability analysis. The e3-Value Ontology includes some base constructs (Actors, Value objects, Value interfaces, Value ports, Value Interfaces and Value exchanges) and defines linkages among them. The constructs and their linkages in the e3-Value Ontology can be used to model a Value Network.

In Ballon (2007), the domain approach introduced by Faber (2003) is used as starting point for a classification. Similar to the pillars used in the BMO, the business modeling consist of four domains or levels representing: i) The value network, ii) the functional model, iii) the financial model and iv) the value proposition (an outline of the future product or service). Ballon (2007) proposed a grouping of the parameters into control parameters (the value network and the functional model) and value parameters (the financial model and the value proposition).

Service innovation, service research and development and business models are the main themes in the book by Bouwman, Haaker and De Vos (2008) where the STOF model is presented. The STOF model has four different domains representing the service, the technology, the organization and the financial aspects. The design process using the STOF method consists of four steps: 1) a quick scan where a simple business model is developed including all four domains, 2) an evaluation of the simple business model using critical success factors (CSFs), 3) specification of critical designs issues (CDIs) and 4) an overall evaluation.

The business model proposed by Chesbrough and Rosenbloom (2002) has been used for the analysis of a large number of companies. The definition contains the following elements: i) The value proposition, ii) the market segment, iii) the cost structure and profit potential, iv) the firm organization and value chain, v) the competitive strategy and vi) the position of the firm in the value network.

Finally, the five forces of Porter (2008) will be mentioned. The Porter model describes rivalry, entry barriers, the threat of substitutes and the bargaining power of suppliers and buyers. Three of the forces come from horizontal competition: threat of substitute products, the threat of established rivals, and the threat of new entrants. Two forces come from vertical competition: the bargaining power of suppliers and the bargaining power of customers. Hence, relations to and cooperation with competitors, suppliers and customers are important. Porters' strategic models also include elements as the value chain and the generic strategies.

5. Conclusion and Recommendations

5.1. Conclusion

The study found out that there was a growing recognition among operators that the rise of viable competition through collocation will force each operator to give of its best in service delivery. This has been intensified by the recent introduction of mobile number portability which allows subscribers to switch from one network to another while maintaining their numbers. This calls for high service quality, and telecom operators in Benue are well poised for this competition by engaging in infrastructure sharing which allows operator to easily extend their network coverage to areas that were covered by their competitor. The study, however, concludes that network infrastructure sharing leads to significant reduction in cost of network infrastructure rollout in the rural areas for telecoms operators in Benue State.

The summary of the findings indicates that network infrastructure sharing eliminates some setup costs such as land acquisition cost, civil works cost, and tower construction cost as well as long and tedious bureaucratic processes of seeking permits. This helps in rapid rollout to new areas while drastically reducing cost of network expansion cost by over 50 per cent. This helps in improvement on time to market. Network infrastructure sharing reduces operational costs such as electricity and security among others leading to operational efficiency.

5.2. Recommendations

From our conclusion, the study came to the following recommendations for stakeholders:

i. Rural infrastructure sharing is strongly recommended (both 2G and 3G) in Benue State because majority of the population are living in rural areas.
ii. The main recommendation is in respect of the epilepsy power supply. It is recommended to the Federal Government to speed up its power sector reforms, as doing so will bring great relief to the infrastructure sharing in Benue State. The tariffs charged by the telecom operators for their services will be drastically reduced and quality of services provided by the operators will also improve tremendously.

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APPENDIX I: Questionnaire Distribution and Retrieval

S/N	Group	Number Administered	Number Retrieved	Acceptance Number	% of Success
	Total	168	164	164	97.6

Source: Field survey, 2014