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Other Factors Influencing the Actualization of NREN and A Business Case for Its Construction in Ghana

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Abstract

This paper critically examines the dynamic influences and issues of developing National Research and Education Network (NREN) in Ghana. From a wider and deeper perspective, this piece is a furtherance of a study by the same authors published earlier. To accomplish this objective, the paper methodologically perused documents and reports of related subject in order to evaluate available information analytically. Qualitative research approach, in the form of interviewing stakeholders, was resorted to each time information from the documents became inadequate. Findings from this study revealed that establishing NERN is practically possible, especially the possibility of funding it from Member fees and an equally higher potential of accelerating production, dissemination and utilization of information resources in the country for the enhancement of teaching, learning and research works.

It was also revealed that the creation of NERN throughout the country would check information asymmetry between rural folks and urban dwellers, especially when second cycle institutions become hooked onto it. Ultimately, the findings have far-reaching implication on policy formulation to regulating the content creation, sharing and utilization.

Keywords: VPN, Monopoly, Oligopoly, KENET, Scale, Router, Switch, POPs

1. Introduction

The idea of National Research and Education Network (NREN) is very not popular in Ghanaian society. The intend of this article is to reecho the call of an earlier article titled, "**investigating the telecommunication network infrastructure in Ghana to identify potential one to use in building National Research and Education Network (NREN) in the country**", Ibrahim and Ismail (2016), for the use of the e-Governance network infrastructure in Ghana to be used in building NREN in the country. The article also intensifies campaign for NREN in Ghana by discussing additional issues to consider in NREN construction, apart from the telecommunication factor.

The document discusses these issues by first discussing literature on issues relating to NREN construction and making a business case for building NREN in Ghana to called GNREN.

2. Methodology

The main methods used for gathering data used in the study are web search, reading relevant documents on NREN and contacts to the Polytechnics and universities for the relevant information. The main data used this article is secondary data type.

3.0 Literature on issues to consider in building NREN

The literature on the issues relating to NREN construction is provided in the subsequent sections and how Ghana would deal with some of these issues to enable construction NREN is also discussed.

In the earlier article we discussed the ownership models briefly and we continue in this issue to look at the approaches to selecting ownership models in NREN construction.

3.1 Approach to selecting ownership model

The ownership model(s) to select may vary from country to country depending on a number of factors as discussed below:

- Regulatory regime;
- Financing or funding options;
- Level of technical expertise;
- The amount of short and medium term bandwidth/capacity requirements;
- The types of applications the NREN will support;
- The extent, coverage and capacity of existing telecom service providers' infrastructure;

It is worth noting however, that the relative implication of these factors may vary, sometimes greatly, depending on the country concern, thus the analysis made could only serve as a guide. The information required to make a decision on the most appropriate model requires careful study on the existence, reliability, performance and gaps in the national infrastructure. This is very crucial preliminary consideration in NREN development.
A very informative and comprehensive study conducted into the most appropriate model required for NREN creation in Africa has being the SARUA study on Optical Fiber for Education and Research Networks in Eastern and Southern Africa by Björn Pehrson et al (2006).

Such studies would map the existing and planned coverage of the national high speed back bone and access networks to the locations of all educational institutions. The survey is extremely useful in determining where the gaps in infrastructure exist, the existence and feasibility of using dark fiber and the current and potential capacities of existing infrastructure.

Traditionally, NRENs in Europe and other parts of the World have simply to, as a start, purchased capacity from existing service providers and created Virtual Private Network (VPN) type networks probably because this model does not require NRENs to outlay large amounts of money for infrastructure provision.
However, European NRENs are now increasingly deploying their own infrastructure or leasing dedicated infrastructure, SERENATE report Deliverable, D14 Report.

3.2 Awareness

Awareness is the education to get the public enlightened on NREN issues and its benefits so that they would understand and not only contribute, but also be part and, or make useful and informative decisions that would facilitate the development process.

As lamented by the Association of African Universities (AAU), lack of awareness at the government and political levels is one of the key challenges faced by attempts at introducing and expanding ICT resources in the continent. In spite of this acknowledgement, there is not known evidence or concrete steps on the ground suggesting universities, polytechnics and research institutions actively engaged or trying to build this awareness to create buy-in. Concerted efforts and steps are required to be taken to raise this awareness and to reecho the significance and role of NRENs in nation building, else their creation and the wider adoption of ICTs in particular would most likely be a wild goose chase; the process would be very slow, tiresome and expensive venture for these higher education and research sectors to undertake.

3.3 Regulation

Education and Research institutions in a country may as well be aware of the impact regulation and national policy could exert on the cost and quality of Internet access or the general set up and operation of NREN. Two of the most acknowledged effects of regulation are the high prices of telecommunications services caused by having either monopoly or oligopoly service provider(s) and restrictive licensing for telecommunication equipments in particular, according to the SERENATE report Deliverable No. 8. However, there are other effects of regulation such as those relating to the setting up and operation of NRENs. The report identifies both direct and indirect effects of regulation on NREN development process as discussed below:

3.3.1 Direct Effects

- **The rights to own and operate networks**

Some countries' telecommunication regulations prohibit institution other than the state owned telecommunication service provider or a Second National Operator (SNO) to build, own and/or operate telecommunications networks in any public space that is, anywhere outside the institutional campus. Some regulations also prohibit the use of VSATs or operation of any form of international gateway. This means NRENs in such situations can only purchase capacity or managed services from existing licensed providers. This could obstruct or deny such NRENs the ownership model that maybe appropriate or cost effective to their development.

- **The ability to obtain Rights of Way and construction permits.**

Right of Way is defined as the legal right to pass through property controlled by another, Report by the Federal Rights-of-way Working group (2004). For telecommunication networks this means the right to access existing or build conduits, trenches, towers, pole lines or have access to other physical locations that modern communications networks requirement.

In some countries, only the licensed operators and other public utility companies have Rights of Way and therefore NREN in such countries could face challenges in trying to establish its own networks according to the report. The Right of Way access even affects individual institutions that have several campuses in different locations and wanting to connect them together.

3.3.2 Indirect effects are often referred to as market conditions and include:

- Lower prices for network services as a result of increased competition due to liberalization
- More variety of networks, providers and services
- Improved service quality brought about by competition

A wide variety of questions are raised about the regulatory status of NRENs. For instance, should NRENs be registered, operate and recognized as licensed operators? As the SERENATE report notes, NRENs in some countries have formal licenses while in others they only operate in grey zones. An interesting example of the former in Africa is KENET in Kenya, which is licensed as a private nonprofit oriented education network operator, Michuki, Mwangi (2013).

3.4 Legal form

On the legal front a NREN is often either independent nonprofit making entity (e.g. NGOs, Foundations, Trusts, and Associations) or semi autonomous government run and owned body (e.g.as a department in a government ministry).According to the European TERENA compendium, the annual European NREN survey reveals that most European NRENs are independent nonprofit making entities while a few are government owned. And that the independent NRENs are separate legal entities owned and controlled by the academic and research community usually with government funding TERENA compendium (2005). Other examples of independent nonprofit making NRENs include theUS'Internet2, UK's UKERNA, Canada's CANARIE, Australia's AARNET, Kenya's KENET, the Dutch Surf and South Africa's TENET.

Independent ownership is likely to be a more attractive option for NRENs because independence spells out:

a) Freedom to operate and respond rapidly to changes
b) Higher chances of being customer-centered and operating as a business, meaning more accountability
c) Ability to negotiate and sign contracts directly and more rapidly and sometimes too, the ability to attract diverse ranges of funding.

Government ownership and management, on the other hand, has one major advantage, and that is the ability to attract long term government (and or donor) funding. However, independent NREN can also attract long term government support especially if it is positioned as national initiative, contributing to overall economic development of a nation (e.g. Surf and its subsidiaries in the Netherlands), Cook Report (2010).

Either independent or government owned, NREN entity is often governed by an independent board of directors or board of trustees usually composed of representatives of member educational and research institutions, government departments or ministries (usually those responsible for education, science, technology and telecommunications) and the private industry. Its operations are in turn guided by a charter, constitution, articles of association or other governing statues according to the Cook Report.

The independence of NREN entity as an operational vehicle requires that its constitution or other governing statutes be well focused and unrestrictive on the core NREN needs. Restrictive clauses that can be major impediments in the future include limiting NREN membership and customers to degree awarding institutions only, limiting the ability of the NREN to own or lease long term assets such as fiber links or limiting the types of services the NREN can offer.

3.5.0 Scale

The motive behind NREN development is often to, either leverage economies of scale, share expensive or scarce but vital national resources for the achievement of an economic advantage(s) as well as realizing a functional need. Large scale or bandwidth demand is a prerequisite for leveraging economies of scale. In the case of Internet access, this requires that there should be as many institutions as possible connected and a pool of aggregate demand to lower costs. The more institutions there are, the lower the cost per institution and the higher the negotiating power of the NREN. In fact, NRENs seem to thrive well where they are able to put together as many institutions as possible to form large scale.

However, NRENs may probably not get easy take off in countries where large scale is not feasible (i.e. small population with corresponding smaller number of education and research institutions) or as in the case of less or developing nations, where institutions are not well funded and as a result not able to own or afford the huge expenses involved in rolling out high-speed telecommunications infrastructure.

The less developed a country, the higher the chances that it would have fewer higher education and research institutions. This compounds the challenges in setting up an NREN. Scale and its associated effects are among some of the most prominent factors that hinder the development of NRENs in least developed nations.

In many parts of the world and in some African countries where NRENs have successfully taken off, they mostly have at least 10 university-level or more institutions connected. Examples include; South Africa's TENET which acts as the appointed agent of more than 50 higher education, research and associated institutions TENET home page, Kenya's KENET connects all 6 public and 10 private universities plus other higher education and research institutions (currently has about 51 members), according to Michuki Mwangi (2013), and that Morocco's MARWAN connects 13 universities, Egypt's EUN connects at least 12 universities and Algeria's CERIST connects 40 institutions. The effects of scale and how to counter them are discussed in the section that follows.

3.5.1 The effect of small scale

The SERENATE report on the workshop on NREN models, notes that research networking can be more challenging and expensive to start in small or less developed countries because of the higher cost to be born per institution and the possibility of dealing with a monopoly provider.

These factors as contained in the report are explored in detail below:

a) Higher cost per user or per institution

The smaller (lesser population and/or fewer institutions) or less developed a country, the more expensive (per user) it would be to provide the same level of service compare with larger countries due to the following four factors:

- Relatively more international capacity is required. The larger the number of higher education and research institutions there are in a country, chances are that there would be high level of local collaboration. Also, the more economically developed the country, the more likely that there would be significant amount of local content or research facilities to share.
- Low-capacity circuits are relatively more expensive on a unit cost basis. The more capacity one purchases, the more volume is counts one expects to receive.
- Circuits of the same capacity are often more expensive in small or less developed countries because smaller countries are likely to have less competitive markets or monopoly providers.
- The NREN in smaller nations need to put in the same amount of effort as their counterparts in larger or well developed nations, to introduce a new service.

b) Higher probability of dealing with a monopolistic provider

Small or less developed countries with limited size markets are likely to have "defacto" monopoly or oligopolistic services providers with probably ill equipped regulators to deal with the situation. In these countries, the institutions are likely to be some of the largest customers of the monopoly provider's services and therefore the provider will resist, sometimes aggressively, any attempt to reduce or erode their revenue base. The provider may perceive the NREN as threat to the monopolistic privileges and is likely to threaten legal action against the NREN or the telecommunications regulator, TENET site home page. Having a monopoly provider also means that the NREN is restricted in the choice of available infrastructure providers and the lack of competition is likely to mean that prices for telecommunications services will be high.

3.5.2 The advantages of large scale

The most conspicuous advantage of large scale is lower cost per institution. There are other advantages of large scale that are not directly related to cost. They include the following;

- **Aggregating bandwidth demand**. Indeed if institutions suffer or are suffering from the effects of high bandwidth prices, low bandwidth and poor services, then chances may be that those institutions will put aside whatever differences they may have and join forces to aggregate their bandwidth demands.
- The more institutions there are speaking with common voice, the more influence they can exert and the likelihood is that they would be able to successfully attract government and donor funding for NRENs and other collaborative ventures.
- Even where government funding is not available, the more institutions there are, the likelihood is that those members will be able to raise sufficient funds to create and sustain a NREN.
- The more institutions there are the likelihood is that no single institution can exercise dominance over the others on the affairs of NREN. A single institution dominating an NREN could be a challenge, for example if the other institutions become dormant in the NREN development process the whole process would be affected.

Scale therefore contributes to the functional need and the economic advantage that drive NREN creation.

3.5.3 Countering the effects of small scale

One of the ways to mitigate the negative effects of small scale is to enlarge the user community. In other words, allowing institutions other than tertiary and research institutions to be roped into the NREN network. It is still possible for countries with only handful of tertiary institutions but with fairly good number of teacher and vocational training and other post-secondary institutions to develop an NREN.

The dream of realizing a NREN development could be fast tracked if tertiary institutions join arms with teacher colleges of education, nurses and midwifery training colleges, vocational institutions and even secondary and primary schools.

Other ways of reducing the effect of small scale as advanced by the SERENATE report include:

- Foster a good relationship with the monopoly telecommunications provider(s) in order to successfully negotiate for lower costs
- Lobby for deregulation of the telecommunications market to allow for competition
- Try to get more funding from the government and donors agents.

3.6 Competition

NRENs can be accused of competing unfairly with privately owned commercial or public network infrastructure providers especially as they are usually government funded. The real issue behind this accusation could be the loss or reduction in revenue earned by the service providers as a result of the factors explained below:

- In many countries of Africa for instance, universities are some of the largest buyers of bandwidth and any attempt to deprive the commercial telecommunications providers of this revenue maybe resisted. TENET in South Africa also provides an insight into this issue. Under the new GEN2 agreement signed by TENET and Telkom South Africa, a key obligation of the benefiting institutions (GEN2institutions) is to ensure that Telkom's monthly revenue does not decline and that any bandwidth price reductions would be matched by compensating upgrade orders.

- In other countries, the educational sector as a whole comprises a large customer base for commercial ISPs. Any attempt to establish an independent provider and cut off this revenue base may be challenged.

Therefore, NRENs connecting the wider educational sector including schools will probably face a tougher challenge from private service providers.

The issue of competition, as the SERENATE report acknowledges, is not easy to prescribe precise solution to, and could be handled differently in different countries, possibly under different circumstances.

3.7.0 Management Issues

Another important factor to consider in NREN development process is management. This is especially true after the successful establishment of the NREN; it then becomes crucial to recruit competent manager and/or management team at the earliest stage to man the NREN infrastructure facility.

It is equally very essential that the services of dedicated full time personnel are engaged to follow up and manage the development and setting up of the NREN.

The business of developing and running an NREN requires management and business skills such as contract negotiation, strategic planning, policy formulation, project management and financial planning as well as the general understanding of the technical issues involved. The NREN founding members mostly do not engage the services of a manager (s) based on academic standing alone but also on proven leadership and management record(s) especially in managing complex ICT programs or projects.

The Board of Directors is also selected on the basis of their experience and contacts that are directly beneficial to the NREN, in other words, on what they are able to offer the NREN. Leatt and Martin (2000) argued that the board should be an expert rather than a representative one. They further argue that the board must be fully empowered by the NREN members to have full authority to manage the affairs of the NREN. The board of directors and not the NREN members should oversee the management of the NREN.

3.7.1 Defining roles in NREN management

3.7.2 Separation of provider and customer roles

Leatt and Martin provide enlightening insight into the subject of service Provider-customer roles. This is a very crucial distinction because it is likely to become a real issue in the NREN development process.

According to them NREN should assume the role of a service provider with the institutions as customers. These roles should be clearly defined and well understood by either of the parties. They should be adhered to and enforced by signing formal contract between the NREN (as service a provider) and the participating institutions as customers.

Separation of these roles reinforces the call for the independence of the NREN so that it can make tough but very crucial decisions for the benefit of all, be accountable and responsive to its customer needs, especially provision of quality services.

It is worth noting that allowing NREN as a service provider to be ran or managed by heads of the IT units or other departments of member institutions risk the danger of potential conflict of interest because they are also customers of the NREN facility. Where there is a shortage of skilled staff to run the NREN, secondments from member institutions could be sought. However, any seconded staff must be willing to resign from their designated roles or preferably resign from their parent institutions to enforce the separation of provider from customer roles.

3.7.3 Staffing

NREN creation in general requires dedicated staff whose energies are focused on getting the NREN created, reviewing infrastructural needs and options and advising for the acquisition or leasing of the necessary infrastructure. Their efforts are also mostly geared towards the operation and maintenance of the telecommunication systems, supporting users and providing additional services as required by the user community.

Running a NREN is a fulltime affair and may not be realized with part-time staff seconded from member institutions. NRENs normally recruit or train the staff they need (both managerial and technical) right from the beginning. They may also be seconded from member institutions but Leatt and Martin (2000) recommend that NREN staff be independent from member institutions or funding agencies.

This according to them would ensure that their real or perceived interests are; the creation and operation of the NREN but not biased towards any institution's interests.
The roles of the staff include: the management team negotiating for complex contracts, setting policy, writing of funding proposals and liaising with the member institutions and the wider Internet industry. The administrative staff would undertake billing, collection, general accounting and book keeping and the technical team would manage the telecommunication and ICT infrastructure. The precise number of staff required will depend on the stage of the NREN development process, the number of members, the ownership model chosen, the types of services to offer or offered and how large the network is. Obviously if the NREN is likely to cover a number of institutions in a country, staffing requirement is likely to grow accordingly with time.

According to the TERENA compendium, the average number of fulltime equivalent staff of a NREN in the European Union (EU) is about forty people of which, on the average, nine are outsourced contractors and the percentage of technical staff is about 69%.

According to the report however, the average number of staff in the middle income non EU countries of Eastern Europe and the Mediterranean region is about twenty of which, on the average, four are outsourced. The percentage of the total staff considered to be technical is about 63%.

NRENs in EU and the Americas are more developed and thus, the level of staffing may not be possible for an emerging NREN in Ghana to justify or sustain. A more informative figure is probably the staffing levels of the non EU countries of Eastern Europe and the Mediterranean region as captured in the report. It goes without saying that the end justifies the means; the development process of the NREN would inform the level of staffing requirement.

3.8 Routing and Switching

Irrespective of the ownership model(s) selected, NRENs usually provide their own switching and routing equipment. Experience of some successful NRENs has it that the major source of complaints of poor services from institutions is attributed to poor routing and switching of traffic.

As the institutions in the GeSCI partner countries intimated they would consider joining an NREN type network only if routing and switching are not left to the monopoly public service provider. Some reasons why routing and switching could become challenges to NREN development and the institutions include:

- Lack of understanding of who has responsibility for switching and routing in the NREN's core network; whether the responsibility lies with the institutions or the NREN or the telecommunications service providers.

- Poorly skilled staff of the telecommunications services provider who are unable to provide proper routing and switching services.

- Reluctance of the telecommunications services providers to provide access to their backbone routers and switches for the NRENs to configure their own optimum routes.

For these reasons, NRENs are better off owning and managing dedicated switches and routers in the NREN network, according to Alex Twinomugisha (2007).

3.9 Security

NREN security policies involve a collection of rules and regulations by which users of the facility must abide by. The essence is to guide and inform users on the requirements and their obligations in protecting technology and information assets. Security issues are normally iterative process, continually improving on what already is being done and what has been done. Implementation of security measures is not organized as a project, but rather as permanent set of integrated information resource management function.

There are a number of security characteristics associated with effective and feasible ICT security issues. They include:

- Implementability
- Enforceability
- Privacy
- Access
- Accountability
- Response
- Flexibility
- Sustainability/Maintainability

3.9.0 Funding

There are three main sources of NREN funding: Government, Donors and NREN member fees. Government funding is usually provided through one or more ministries, departments or other such bodies responsible for education, science, technology, telecommunications and/or research.

Donor funding includes funding from bilateral and multi-lateral development organizations, public and private foundations, Non Governmental Organizations (NGOs) and private industry. Member institutions contribute to funding mainly through payment of fees for the services they receive.

3.9.1 Government and Donor funding

Government and donor funding are very crucial in the initial phase of establishing the NREN and acquiring the physical network. Aside the initial phase, this funding is also required to continuously upgrade and extend the physical network and the development of new services.

Leatt and Martin's paper outlined in detail, the reasons for which it is important for government or donor(s)(especially external) to fund the initial phase of the NREN development.

They argued that external (donor) funding is necessary not only to finance the deployment of new infrastructure, but also for the pre-start up costs of getting collaborative ventures properly conceived and structured. Pre-start up activities include assisting the educational and research institutions in establishing a strong and knowledgeable team tasked with the responsibility of negotiating for better rates with telecommunications and other service providers. In general, donor and government funding acts as catalyst to NREN development, the TENET story.

In sub-Saharan Africa, some NRENs' creation (both the organizational set up and the physical network infrastructure or capacity acquisition) benefited from donor funding. In the initial phases, TENET in South Africa benefited from funding of the Mellon Foundation and the fore-runner UNINET relied on funding from the South African government's Foundation for Research Development (FDR), Foundation-Partnership.org/profiles. KENET in Kenya initially benefited from funding from USAID for its initial development.

When governments and donors fund NRENs, the funds may be disbursed directly to the NREN (central funding) or channeled through the NREN member institutions. According to the SERENATE summary report discussed the advantages and disadvantages of central funding against funding through member institutions, in general central funding is most appropriate in three cases:

i. During start up phase when NREN needs to make decisions quickly
ii. In economically challenged countries, where institutions are generally financially handicapped, NREN funding when channeled through such institutions would compete with other equally important ventures
iii. For testing of new technologies and the development of new services that are of long-term benefits to users in general, but of no direct short-term return to individually connected institutions.

Conversely, funding through member institutions (usually on the basis of capacity, usage or both) provides a strong incentive to NRENs to keep adapting the services that they offer to the actual needs of users.

3.9.2 Member fees

Member fees are very essential for the running and sustenance of NRENs. These fees come in the form of annual contributions (membership fees) and payments for services provided such as Internet access which usually comes from the institutions' own budgets. Interestingly, where NRENs do not build dedicated networks but leased capacity from existing providers (where no high initial capital outlay is associated) the NREN is likely to be funded largely from member fees. Sometimes, member fees are seen as indirect government contributions because most institutions are funded by governments in the form of subvention.

It may not be possible to say exactly to what extend a NREN would survive on member fees but what is clear is that these member fees are critical lifeline of NRENs according to the TERENA compendium.

Reviewing the compendium which has one of the most detailed analysis of NREN funding in the EU area, Eastern Europe and the Mediterranean region reveals that on the average NRENs obtain about 36% of their income from member fees, TERENA compendium (2005).

However, this varies widely from NRENs that rely100% on member fees to those that are fully funded by government.

Relying on member fees has both advantages and disadvantages to NRENs. A very conspicuous advantage is that a NREN can be more accountable to and provide high quality and relevant services to its members. On the other hand, member institutions especially in Africa are generally poorly funded and are unable to contribute the kind of sums required to build and extend infrastructure or provide more capacity. This may result in a situation where members may receive bandwidth capacity in proportion to the amount of payment thus relegating the intended benefits of NRENs to the background.

3.10 Financial Sustainability

Donors would most likely fund projects such as NRENs provided that they demonstrate financial sustainability in both short and long terms. The expectation is usually that member fees should cover all running and operational costs.

This expectation is often unrealistic for the following reasons:

- NRENs' operating costs include significant costs for equipment and infrastructure upgrade which are very high and may well go beyond the capability of members to finance
- As noted earlier in the research, member institutions require advanced network services which commercial providers may not be willing to provide to such communities perceived to be relatively small and with low purchasing power.

The solution could probably be to position a NREN to receive long term funding. This sort of long term funding can only be obtained from national governments (or donors acting through national governments). The SERENATE summary report strongly recommends that governments could be reminded that research and education networking in their countries, and in particular their NREN, is an asset for economic growth and prosperity.

Charging member fees ensures that the NREN stays responsive to the members needs. Further, it is inconceivable that any NREN is ever going to have enough government or donor funding. Rather, member fees may be considered as an integral strategy for raising funds and for the sustainability of the NREN.

3.11.0 Strategies for NREN

NREN development in least developed countries would most likely choose ownership model(s) that do not require large initial capital outlay. This means probably purchasing managed services or purchasing capacity (models 3 or 4 of Network ownership model), Morten et al (2003). However, in such approaches, one is likely to encounter a major hurdle: the country may probably not have enough existing extensive high capacity network to support (the possibly widely spread) institutions to provide the kind of large bandwidth capacity required by them.

In most cases, the educational sector forms a relatively huge (potential) Internet services

market by virtue of the fact that it becomes the most likely sector to have the most installed bases of computers than any other sector.

With the current convergence of voice and data, increases in data over voice traffic and erosion of traditional voice revenues from land line services, service providers are likely to listen to anyone with a substantial bandwidth demand. They may sometimes be pressed to ignore an aggregated educational market that the NREN may create. There are two ways for the NREN community in a country to increase their influence and negotiating power. They include:

a. **Thinking big**

NREN will have to unite institutions and serve the whole higher or even entire education sector of a country to create one huge purchasing block, thus creating large scale. Having significant scale is an incentive for service providers to extend their networks.

A telecommunications service provider may find it financially viable to extend its network to cover a single tertiary institution and a hundred Senior High Schools (SHS) as opposed to just two to three such tertiary institutions.

b. **Leverage high bandwidth demand**

NREN in a country ought to be aware that it could potentially become the largest single consumer of bandwidth especially if it is able to leverage significant scale by aggregating bandwidth for the wider higher education or even the entire education sector. Projecting short and long term total bandwidth needs and presenting this to telecommunications service providers might convince them to lower prices of capacity and also upgrade their networks.

If service providers realize that NRENs might be ordering for capacity in Giga bits rather than kilo bits, they might be willing to make significant discounts and upgrade and extend their networks.

Another benefit to the service provider is that the institutions and the educational sector in general could most likely be reliable and long term customers since they are well established and the demand for Internet services would always exist and probably continue to grow; thus reassuring them of continuous demand of services.

The other strategies that NREN could consider in countries with poorly developed national infrastructure include:

c. **Joint Venture**

Where NREN has funds to build some segments of the network but is unable to do so because of the telecommunications policy, NREN could consider a joint venture with existing licensed provider(s). Such joint venture could be carefully designed to be in the interest of the NREN.

d. **Position NREN to benefit from Universal Access Funds**

If NREN is recognized as a public asset, it could benefit from Universal Access Funds (UAF) run by some countries especially when it comes to extending their networks to rural or underserved areas.

3.11.1 Positioning NREN as national initiatives

The strategy to turn an NREN into a national initiative and by that giving it a national face would have to adopt a number of strategies. A few of such approaches are discussed below; however it is worth noting that whatever approach is taken will have to take into consideration, the local context of the country involved.

Examples of such approaches include:

a) **Create a national inclusive advisory committee**

The potential members of the NREN could endeavour to create a national advisory committee or task force during the conception, design and development to include all parties (or stakeholders).

The committee could comprise members with substantial influence that could exert positive impact on the NREN development process. These stakeholders could include government ministries and departments, representations from the different educational sectors, NGOs interested in education and research in general, donors and the private sector.

Such an advisory group may not be able to meet regularly as it is likely to be a large body. They may probably (or be encouraged to) select a smaller committee of members to monitor the day to day activities of the NREN development on behalf of the larger group.

This approach makes it possible and somehow easier to raise awareness, make various stakeholders feel included, and the likelihood is that the NREN will be upheld as a national initiative and by that enjoy national recognition and acceptability.

b) **Hold targeted meetings with key stakeholders**

Holding carefully planned consultative or briefings and workshops with the relevant ministries, government departments, targeted educational and research institutions, telecommunications infrastructure providers, private sector entities involved in ICTs in education and key donors makes the NREN development process an all inclusive affair. A small group comprising representatives of potential NREN members could be selected to undertake this consultative mission. The consultation serves the purpose of raising the awareness and solicits feedback from targeted groups and would most likely create buy-in.

c) **Lobby for a dedicated central budget for the NREN**

Another strategy is to lobby the relevant line ministry or department to consider a distinct budget line for the NREN, no matter how small it is. This requires considerable lobbying of the relevant units of the ministry including the planning and budgeting office. The most important consideration is not how large the initial budget is but the principle of its establishment; which is a sign of commitment or budgetary support from central government.

d) **Invite top leadership to launch NREN**

Getting the top political leadership to launch the NREN is a positive step in its development process. For example, Internet2 in the US was launched by former Vice President Al Gore, www.CNN.com. This kind of inclusion and participation at the highest political level is important to secure long term commitment and could possibly generate media coverage and hence generate awareness for it, both locally and international.

Another way of gaining higher level political support is the assurance of openness and non corrupt practices especially with the handling of NREN funds and other related financial issues involved in its development process.

3.11.2 Approach to collaborating with other educational sectors

Where the NREN is opened up to the entire higher education (including post secondary) sector or even the entire education sector (including Senior High Schools),the telecommunications network can be designed with virtual networks to serve specific sectors. For instance, the virtual network serving universities and polytechnics may be of much higher capacity than those serving other sectors. This lends the advantage of tailoring services and applications for each sector while still leveraging collective purchasing and organizational power.

3.12 Important government stakeholders in NREN development process

Government at different levels could be considered a critical stakeholder for NREN development. The most important levels or government bodies to engage include:

- **The Council for Higher Education**

The country's body that is directly responsible for advising government on higher education matters is the National Council for Tertiary Education (NCTE).This councilor body is also in charge of accrediting or licensing higher education institutions and in setting and monitoring quality standards for the higher education sector. The council can have greater influence in support of an NREN creation on the government by advocating for its creation or funding.

- **The council or body responsible for research**

Some countries have dedicated public organizations or government departments to oversee advice and set the national research agenda. The Council for Scientific and Industrial Research (CSIR) is charged with the responsibility of overseeing the national research agenda in Ghana. Support from such institution could be very crucial for an NREN development.

- **The ministry directly responsible for the education sector.**

It is very important that this ministry buys into the NREN concept and its attendant benefits as it is responsible for allocation of funds to the education sector. The ministry's attention could be called to the possible challenges that may be posed by attempts at achieving scale. The fragmentation of the education system, between higher and basic education, and possibly dealt with at the political level. The result of this fragmentation could lead to duplication of efforts in the higher and basic education sector.

- **The ministry of communications**

The communications ministry is particularly important as it is responsible for enacting overall telecommunications policy and for planning and (directly or indirectly) building the national infrastructure. The national telecommunication policy can make or break the development of NREN depending on whether or not it supports its development.

For example, if the policy prohibits the use of private VSAT systems and there is no submarine fiber cable access or if the policy promotes a monopoly national infrastructure provider, then NREN could face severe challenges in trying to reduce international as well as national bandwidth costs.

The Ministry of Communications also sometimes controls the Universal Access Fund, where it exists. NRENs should be positioned as possible recipients of such funds which could be used to build and extend the infrastructure. Finally this ministry also oversees or has

significant influence over the telecommunications regulations in a country.

- **The Telecommunications Regulator**

The National Communications Authority (NCA),the telecommunications regulator, is responsible for overseeing and implementing telecommunications policy and for granting critical licenses such as ISP and VSAT licenses. Obviously the support of such body is critical for the successful creation of NREN in a country.

- **The Ministry of Finance**

This ministry of finance holds the national purse. More importantly, the finance ministry has significant influence over donor funding and its allocation. This is especially true in countries that have moved to direct budget support model of donor financing away from the traditional project financing model.

Institutions wishing to tap into this type of (usually large) donor funding could ensure that the NREN initiative is identified in the national Poverty Reduction Strategy Plan (PRSP) and other such national development plans.

- **The President's Office**

The top political leadership usually has clout and can influence other ministries or departments. Interest from the top leadership in the development of the NREN is possibly one of the surest ways to ensure access to continued public funding and other support.

- **National Parliament**

Parliament enacts and approves the country's laws and regulations. If the NREN could be created or supported by an act of parliament, then the NREN would most likely be guaranteed of long term government funding and would also be in a strong position to tap into a larger pool of donor funds.

How far up the government ladder one needs to go to obtain buy-in and how to position the NREN as a national initiative will depend on the prevailing local conditions.
One could endeavourto read between the lines, know where the necessary influence, support and funding in the government lies. Positioning the NREN as a national initiative also means involving other sectors such as the private sector, which is important to obtaining the buy-in of the infrastructure providers and to obtain additional funding.

4.0 Proposed NREN for Ghana

The other issues involved in NREN construction have been discussed as above, the next section discusses how to approach or deal with these issues to enable the realization of NREN in Ghana.

Proposed National Research and Education Network for Ghana shall be called Ghana National Research and Education Network (GNREN). An attempt at developing the GNREN in the country would have to adapt strategies that would make this dream realizable. It has to take into consideration the available national telecommunications and ICT infrastructure (including that of the various intuitions) in the country that we could make use of and those that need to be upgraded. Fortunately, Ibrahim and Zakaria (2016) have indicated the availability of such ICT infrastructure.

Pragmatic strategies should be designed and strictly adhered to; to avoid falling prey to some of issues that hindered earlier attempts at constructing NREN in the country.

We have to make use of the experience of nations that have been very successful in terms of research and education network (e.g. Netherlands) and also learn from best practices from the

NRENs of such nations.

4.1 Strategies for GNREN

The strategies to adapt in the development of the GNREN for Ghanaian institutions would be to start a GNREN for Ghanaian tertiary institutions, some of which are already on the GARNET as prelude to connecting all Ghanaian education and research institutions. The steps that would be taken to realize the strategies are discussed as below:

1. First, the tertiary institutions need to be educated, using a variety of techniques, on the need for GNREN in the country. This would likely generate awareness and possibly acceptance in its creation by the communities proposed. Awareness and acceptance would most likely result in buy-in which could also possibly result in getting their commitment in the course of the GNREN development.

The benefits of NRENs as discussed in an earlier article by the authors, would be explained to them in clear and easily understood forms, so that they could make informed decisions on whatever feedback is expected from them. Enjoying unanimous acceptability, support and possibly commitment from the proposed communities is a sure way to getting the nod to proceed with the GNREN development process. The steps that would be taken to create the awareness in the tertiary institutions include the following:

- ***Selection of a national coordinator***

The responsibility of the coordinator at the rudimentary stage would be to coordinate the activities of the various campuses and liaising up with colleagues on the campuses to help in the organization of meetings, workshops, seminars and symposia for the proper education and dissemination of information on the need for the GNREN in the country.

He/she would be charged with an additional responsibility of establishing and maintaining links with the government and all the agencies that matter in the GNREN development process to listen and possibly give attention and commitment to its course of development. In addition, he would serve as the link between experts and successful NRENs abroad to learn from their rich experience, best practices and seeking of advice.

- ***Campus coordinator for each tertiary institution would be selected***

These coordinators would be charged the responsibilities of actively organizing meetings, workshops and symposia in their various campuses to educate their people about the benefits to derive from GNREN. Sometimes other coordinators and possibly with a national coordinator would visit the institutions to help their colleagues deliver lectures and presentations on GNREN as and when the need arises. Some of the staff of the institutions who have received training in Masters of Telecommunications Management would be used on campuses where they exist. Arrangements would be made to give special education to some staff of the institutions that do not have such experts (e.g. the universities and some Polytechnics).

The national coordinator and some of his/her colleagues would have to visit such institutions frequently for presentations, briefings and lectures to intensify the education and campaign for GNREN.

- ***Organization of workshops, seminars and symposia***

When the campus coordinators and the national coordinator have been formed and established, the next step would be for them to meet and decide on how to package and sell the idea of the GNREN creation on the various campuses. How to source for funding for the workshops and symposia would be discussed and each assigned role(s) to raising the funds. The target group (i.e. the Polytechnic and Universities) would be segmented into groups based on the level of awareness of ICT and its attendant benefits, the level of influence on the GNREN development process and how important GNREN would be to the group in particular. Strategies would be drawn along these lines to woo their support and commitment.

- ***Holding targeted meetings with top management of the Tertiary Institutions***

The coordinators would select some of their members to form a committee that would meet and try convincing top management to buy-into the idea of GNREN development for their institutions. This would include not only the Rectors, Vice Chancellors, Registrars, Finance Officer, Internal Auditors and Liberians of the various institutions, but also the governing councils and the academic boards of such institutions. The leadership of University Teacher Associations (UTAG), Polytechnic Teachers Association of Ghana (POTAG) and Students' Representative Council (SRC) would also be met as many times as possible to get their support and commitment.

In all these meetings, the success of some NRENs like Surf in the Netherlands should be explained to them. Any agreement reached with top management, in particular, on the GNREN development process should be recorded in a Memorandum of Understanding (MoU).

- ***The importance of the Internet should be used as a tool to getting any group that has little or no idea about NREN convinced***

In one way or the other, some of the group members might have attempted using the Internet in this part of the World and encountered the challenges of unreliability, slowness and high cost associated with its use.
The reasons for these challenges and how the proposed GNREN intends resolving them should be explained during these meetings.

2. Second, the government and her agencies would be the next target in the GNREN building efforts. This is especially so when in an earlier article by same authors on NREN, a proposed proposal was made to using the e-Government network infrastructure to build NREN in the country.

Special (targeted) meetings with the Government to get her convinced should be employed. Expert advice could be sought and sometimes using other governments who are in good relations with our government to engage and or, discuss issues about the role required of a government in the development of an NREN on our behalf. The President or his Vice could be invited to launch the GNREN development.
This may give it a national face and ownership and may through that draw the world's attention to its development process which could be a weapon for sourcing international funding.

When the support and commitment of the Government is won, then the opportunity should

be used to engage or seek the support of the government to engage the telecommunication service providers to dialogue on how they could also play a role to help the GNREN development.

As part of the engage of the Government, parliament should be made to back the construction by legislation. For instance, in November2008, parliament approved a $30 million concessionary loan facility that has been extended to the government of Ghana by the government of China for the construction of the initial phase of a nationwide e-Government infrastructure (e-Government Interoperability Framework (e-GIF)) (Ibrahim and Zakaria, 2016). Thus the parliament of Ghana has the history of approving documents concerning such vital facility when positioned as national initiative.

3. The issue of scale form challenges to some countries and serves as impediments to the development of NRENs in those countries. Fortunately the issue of scale is not a major one in our case. For instance in Ghana there are about 54 universities (13 public and about 41privateuniversities), 10 Polytechnics, 38 Colleges of education and a number of research institutions, ghanauniversalities.com. Each of these institutions has substantial number of students to guarantee member fees as start up fund for the GNREN in Ghana.

The institutions together form a good scale to deal with the issue of scale.

4. Targeted meetings with the telecommunication service providers would be another priority in the development of GNREN. During the meetings and presentations, efforts should be made to allay their fears that GNREN is coming to be another competitor. Instead they should be made to understand that the success of GNREN would rather create more market for them. Currently relatively very few Ghanaians (especially students) use the Internet service. Having GNREN means the institutions together would aggregate demand for bandwidth, thus increasing demand for bandwidth as more students and staff would now use the Internet. When GNREN successfully exposes them to the benefits of the Internet, in their homes they might not have access to GNREN and would definitely use the services of the ISPs. This is especially true when they complete their courses of study and out of campus, they would like to have access in their homes and possibly at workplaces.
5. In like manner, external advice should be sought on how to identify and approach donor agents interested in education and research development. If possible, meetings should be held with such identified donor agents to seek their support and commitment as well. With the guidance of the experts, proposals could be written and sent to the donors for support to the development of GNREN.

4.2 Proposed Network Infrastructure

The writers of this paper in their earlier publication proposed using thee-governance network infrastructure to building NREN in the country. The network links almost all government departments and institutions in the country.

This makes it a very crucial source of infrastructure for the GNREN.

Concerted efforts need to be devoted on negotiation and lobbying with the government to appreciate the need for an NREN for the country and through that convince her to avail the network for the GNREN to use in building its network. To achieve this, it has to be positioned as a national initiative.

Evidence of such NRENs becoming source of innovation and providing fast and widespread technology to society and industry (e.g. Surf in the Netherlands) could be used to make her see reason for the urgent need of an NREN in Ghana and how crucial the e-Government network is to realizing that dream.

All the Polytechnics, Universities, Colleges of education Second cycle institutions and some social institutions like the Police stations have been capture in this network. This makes it very crucial for our GNREN development vision especially when governments have proven to be very important stakeholders in NREN development in other parts of the world.

Efforts should aim at connecting the Universities that have already been connected to the GARNET (e.g., University of Ghana, University of Science and Technology, University of Education, Winneba and University for Development Studies) to begin with for the reason that these are institutions some of which are already attempting to have NREN trough the GARNET network.

These institutions can easily be convinced and more so they are also connected by the e-governance network. If we are able to, through GNREN, achieve some success, in terms of Internet speed, reliability and lowering of cost, a very positive image of the GNREN would be created in the country and it would become easier getting some level of commitment from the other institutions and the Government.

This does not mean the process of connecting the Polytechnics and the other institutions would have to wait. It would indeed continue and the institutional local area networks would be upgraded in the other institutions in preparation towards hooking up onto the GNREN ultimately.

The process would continue until all of them are connected to form the GNREN of the nation.

Success in doing that would be claimed and announced time and again to whet the throats of the other institutions (Universities and others) to join.

4.3 Management of GNREN Facility

The proposed GNREN facility should be manned by an interim management committee (i.e. the coordinators, both campus and national) and a member from the Ministries. These coordinators with the management of the institutions and the Government representation should stir the affairs of the facility. They would recruit and send for training, some of the technical staff needed to manage the GNREN equipments. They would also determine the other staffing requirement, managers, accountants, marketers, secretaries, to mention but a few. After its successful establishment, a board of directors should be formed to oversee the effective and efficient management of the GNREN of the country on behalf of the founding institutions. This would include people with vested interest in education and research and to some extent, technical knowledge or know-how in such ventures.

4.4 Staffing

In the interim, the services of technical staff may be hired. Depending on the availability of funds and the advice of experts, training of technical staff could begin when feasibility studies for the project is complete and some commitment of funds got from the government, out of the institutions contributions and probably from donors. When the GNREN is successfully established in these institutions, then the recruitment or training of substantive manager or management team who would serve as full-time employees of the facility should follow. The coordinators serving as interim management committee members would stir the affairs of the GNREN, with support from experienced NRENs (e.g. Surf)until substantive management team is in place.

4.5 Funding

Funding for the GNREN would most likely come from three main sources in the start-up phase: Government, Donor agents and Member fees. We would also seek advice and guidance from existing well functioning and very successful NRENs (e.g. Surf in the Netherlands)in the world today on other means of raising funds for the GNREN facility. Concerted efforts should be made to get some funding from the government since that would most likely convince donors about the commitment of the state.

We should as much as possible involve the government in the development process to make her part of its development.

Each academic year some amount of money is set aside by the government of Ghana to the Ghana Education Trust Fund (GETfund) through the National Council for Tertiary Education (NCTE) for infrastructure and staff development of the various tertiary institutions. Lobbying with the government to commit some percentage of this fund to the development of the GNREN is very important in this process. The ministries of education and communication would as well be convinced to commit part of their annual budgets to the GNREN development.

Proposals should also be developed and submitted to donor agents like, USAID, Mellon Foundation and other such agencies. Apart from those mentioned information on other donors who may be interested in research and development should be sought and proposals sent to them to source for funding.

Member fees would be another source of funding for the proposed GNREN. Fortunately, each of the educational institutions charges students ICT user fees. In the Polytechnics in particular, students paid up $35.00eachasICT user fees, this could be channeled into the development of the GNREN. Efforts should as soon as possible be made to have discussions with the management of the tertiary institutions on the need to use these fees to commence development process of the GNREN and also hold discussions with student leadership for the upward adjustment of the figure.

4.6 Financial Sustainability

Considering the huge initial capital outlay required for NRENs, coupled with the fact that they are nonprofit oriented organizations; it may not be possible form ember fees of the tertiary institutions alone to sustain the infrastructure. This is possibly exacerbated by the fact that the government of the country is always hard pressed with budget deficits and other constraints.

Support from the government side and member fees alone may not be able to sustain the GNREN facility for long. However, some donors interested in funding such projects would expect demonstration of financial sustainability by the NRENs before they grant financial commitment.
Another way we would try sustaining the venture may be to seek joint venture partnership with well established NRENs like Surf, so that in addition to making their rich experience available, they may jointly finance it until such a time that it gains its feet.

4.7 Security

Security issues in any network environment are of critical importance. As a result, the following requirements for securing network resources would be adhered to:

- Ensure that only authorized individuals have access to the information they require;
- Prevent unauthorized creation, alteration and or destruction of data;
- Ensure that legitimate users are not denied access to information;
- Ensure that resources are used in legitimate ways;
- Careful handling of staff grievances to safeguard the situation of aggrieved or dismissed staff linking vital information to the public or unauthorized users.

The following measures should also be taken to ensure that the network (both campus and GNREN core network) would be secured. They include:

- Ensuring that the GNREN core network is built with switches since this almost eliminates the possibility for users of “snooping” accounts and passwords from the network;
- Links between switches should be wireless and possibly fiber optics
- Encrypted communication methods (like SSH instead of telnet, https etc.) should be used in both the campus area network and links between the institutions.

5.0 Business Case for NREN in Ghana

GNREN has the potential of growing into a large venture considering the ever increasing demand for bandwidth by the education and research institutions in the country. When it becomes successful in the Universities (both public and private) the Polytechnics should be hooked onto it; the Colleges of educations, Senior High Schools (SHS), the Junior High Schools (JHS) and possibly the primary schools could most likely join later. This presents a very good business case for the GNREN in the country. When all these institutions and organizations become finally hooked onto the GNREN, there would be large scale which would in variably reduce the high cost associated with bandwidth to individual institutions and make it possible and more economical to acquire and or share very vital but scarce resources (e.g. e-content)than any of such institutions or organization could afford alone.

Majority of staff and students of the country’s institutions have little or no knowledge about NRENs. When through the proposed GNREN, bandwidth is made available to them and they are introduced into the other benefits (e.g. sharing of resources on the network among others), more and more would be required of the bandwidth and extension of the GNREN would be made to the benefit of all(including telecommunication service providers).

Ghana is surrounded by countries (Cote d'Ivoire, Burkina Faso and Togo) that there is no evidence as of now that they are actively involved in the development of NRENs. If the GNREN is well established and functioning, such countries might find it more prudent to get linked up to the GNREN instead of starting their own from the scratch. In effect, the GNREN has the potential of growing into a very large network infrastructure and possibly developing into an Internet Service Provider (ISP) like SURF in the Netherlands.

5.1 Initial cost of the GNREN

The initial cost of GNREN would include:

- Cost of educating the GNREN community on its need and creating awareness for buy-in and commitment should be one of the cost components. This would take the form of organization of workshops, symposia, seminars and targeted meetings. Travelling round the country for these activities and holding meetings with government and telecommunication service providers may form another component of the cost. During the workshops, snacks and sometimes breakfast or lunch would be provided for participants to encourage regular attendants.
- The coordinators (both campus and national) would be given some allowances as motivation to getting them give off their best and commitment. They may also be given laptops and General Packet Radio Services (GPRS) modems to equip them with modern tools of communication for efficient and effective communication.
- Cost of leasing network infrastructure to build the core GNREN backbone may form part of the initial costs. This cost may depend on agreement reached with the government on the part that she would bear. Network equipment like switches, routers, modems and servers would be GNREN's initial cost components too.
- Travelling and lodging costs (e.g. transportation) would be required to enable the ease movement of the national coordinator in particular to liaising up with his/her colleagues to discuss pertinent issues concerning GNREN. This may also be used by external consultants to conducting further feasibility studies and building of the network.
- There would also be cost of media briefings, advertising, announcements and possibly posters.
- The remaining cost would be associated with renting of temporal offices for the GNREN, payment of the salaries of a secretary, office equipment, office stationery, utility bills etcetera.

It might not be possible to quantify the costs enumerated above. The document therefore recommends feasibility studies into these costs so that exact figures would be made available for the GNREN development.

5.2 Revenue

At the moment each student of the various Polytechnics pays $35.00asICTuser fees. This could be a source of revenue to GNREN development. However, it depends to a greater extend on the student numbers, the greater the numbers, the higher the revenue and vice versa.

The following tables give approximate student figures from the various Polytechnics and Universities and estimated revenue to derive from member fees based on the approximated numbers.

Name of Polytechnics	Student Population	User fee/Student	Member fees/ Polytechnic
Tamale	5000	$35.00	$175,000.00
Bolgatanga	1,500	$35.00	$52,500.00
Wa	2,000	$35.00	$70,000.00
Sunyani	3000	$35.00	$105,000.00
Kumasi	5000	$35.00	$175,000.00
Takoradi	7,000	$35.00	$245,000.00
Cape Coast	3,500	$35.00	$122,500.00
Koforidua	4,000	$35.00	$140,000.00
Accra	4,000	$35.00	$140,000.00
Ho	6,000	$35.00	$210,000.00
Total			**$1,435,000.00**

Table 1: Projected member fees from the Polytechnics

Name of University	Student Population	User fee/Student	Member fees/ University
University of Ghana	38,000	$35.00	1330000
KNUST	23,000	$35.00	805000
University of Cape Coast	15,835	$35.00	554225
University of Education, Winneba	3000	$35.00	105000
University Institute of	10,000	$35.00	350000
Asheisi	505	$35.00	17675
Ghana Telecom University	1,500	$35.00	52500
Central University	8,400	$35.00	294000
Pentecost University	3,874	$35.00	135590
Total			**$3,643,990.00**

Table 2: Projected member fees from the Universities

In terms of student population, the universities have larger numbers, and that means the possibility of raising higher revenue from member fees would most likely be great.

How much could be realized from government and donor agents would depend on how successful negotiations have gone. With this approximate figure, the member fees from the institutions seem convincing to start the GNREN with and for any external donor to invest in.

6. Recommendations

We recommend a feasibility study to assess the feasibility of using the e-Governance network infrastructure for this purpose and the strength of local area networks of the tertiary institutions. We recommend also assessment of the national ICT infrastructure.

We recommend further that negotiation with the member institutions, the government and her agents be given serious consideration.

Finally, the membership of the proposed GNREN seems great; therefore we recommend that strategies be put to consider starting the GREN with membership fees.

7. Conclusion

In conclusion, we insist that there is no reason to wait, the telecom infrastructure is already available, and the financial base of the proposed institutions is equally great. The process for the construction GNREN can no longer wait, the time to do it is now. This study is inexhaustible and therefore, future research effort can be directed towards feasibility and viability study of all that is discussed in this paper towards implementation and operationalizing of GNREN.

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