



APPLICATION OF LEAN PRINCIPLES BY THE VOLTA RIVER AUTHORITY OF GHANA – PROSPECTS AND BENEFITS

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Abstract: This paper examined the prospects and potential benefits that could accrue to the Volta River Authority (VRA) of Ghana through the application of lean principles in its power manufacturing processes. The research employed secondary data from documented research papers and periodicals. Other secondary data sources included news bulletins, financial statements and strategic plans, and survey reports by the VRA. The VRA is Ghana's major power generating company but grapples with inadequate power production. This has adversely affected the country's socio-economic growth as businesses and households spend more on expensive alternative power sources. While funding is a major constraint, systemic wastage is another. Thus, if waste is minimized, production cost would reduce as revenue is maximized. The wastage manifests in forms including non-value-add activities such as delays, overproduction, and plant and personnel underutilization among others. Ridding itself of such wastage, which would include non-value-add activities, would free capital for the company to pursue more value-add activities for optimal benefits. The wastage or otherwise non-value-add activities identified include unpaid revenues, delayed information flow, excessive stores and staff and machinery underutilization. Others are frequent and long meetings and conferences, and the untapped potential in Information Communication Technology (ICT).

Keywords: Lean principles, power manufacturing process, waste elimination and operational efficiency.

1.0 Introduction

Lean philosophy gained prominence following the success story of Toyota Production System in the 1930s and was popularized by the publication "Lean Thinking: The Machine that Changed the World and Lean Solutions" by Jim Womack (Lean Thinking, 2017). According to McKinsey (2017), lean thinking leads to a dramatic reduction in production cost, typically between 15-30 per cent. In other words, it focuses on eliminating or minimizing waste while adding value to a product or service to meet customer needs.

Organizations that go by lean philosophy are able to sustain production levels with half the personnel strength, improve quality and reduce cycle times from 50 – 90 per cent (Lean Thinking, 2017). Motivated by these gains, several companies across different business leanings have followed Toyota's lead to also embrace lean principles and are reaping the benefits thereof. For example, a European Bank, according to McKinsey (2017), applied lean principles to its mortgage applications and succeeded in drastically reducing processing time from 35 to 5 days.

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The result was a 35 per cent processing cost reduction which translated into a 5 per cent revenue growth.

Ghana's power supply has been erratic for almost a decade. Nonetheless, demand continues to outweigh supply. Although the proportion of the population with access to electricity is almost 80 per cent and ranked second in sub-Saharan Africa, the erratic nature of supply leaves a lot to be desired. The effect on the economy cannot be overemphasized as it is noted to have contributed to the decline in real Gross Domestic Product (GDP) growth of 14 per cent in 2011 to about 4 per cent in 2016 (Energy in Ghana, 2017). The situation has been blamed on factors including inadequate power generation, inadequate funding, distribution losses, and obsolete equipment.

The country's power sector comprises many companies performing different roles (See Appendix). This necessitates the effective management of all stakeholders. The VRA is the main power generation company. It runs 83 per cent of the total national installed capacity of 4,275MW (Energy in Ghana, 2017). It is a state company that receives a lot of blame for the current situation. To effectively remedy the situation, it is expedient that the company explores opportunities to increase production while minimizing cost. The application of lean principles has potential to turn the company's fortunes around in this regard.

This paper discusses the extent to which VRA could apply lean principles to its power manufacturing process to reduce cost and increase production to meet the 10-15 per cent per annum growth rate in demand (Guide to Electric Power in Ghana, 2015). It first defines what constitutes value to the company's customers mentioned in the Appendix. Thereafter, the value stream of the company is discussed, with particular attention to non-value-add activities and how they may be addressed. Then, a design of value creating steps aimed at ensuring a continuous flow of value which the customer can pull is

illustrated. Finally, the importance of pursuing continuous process improvement is discussed and a conclusion drawn.

2.0 Theoretical Framework

Value Definition

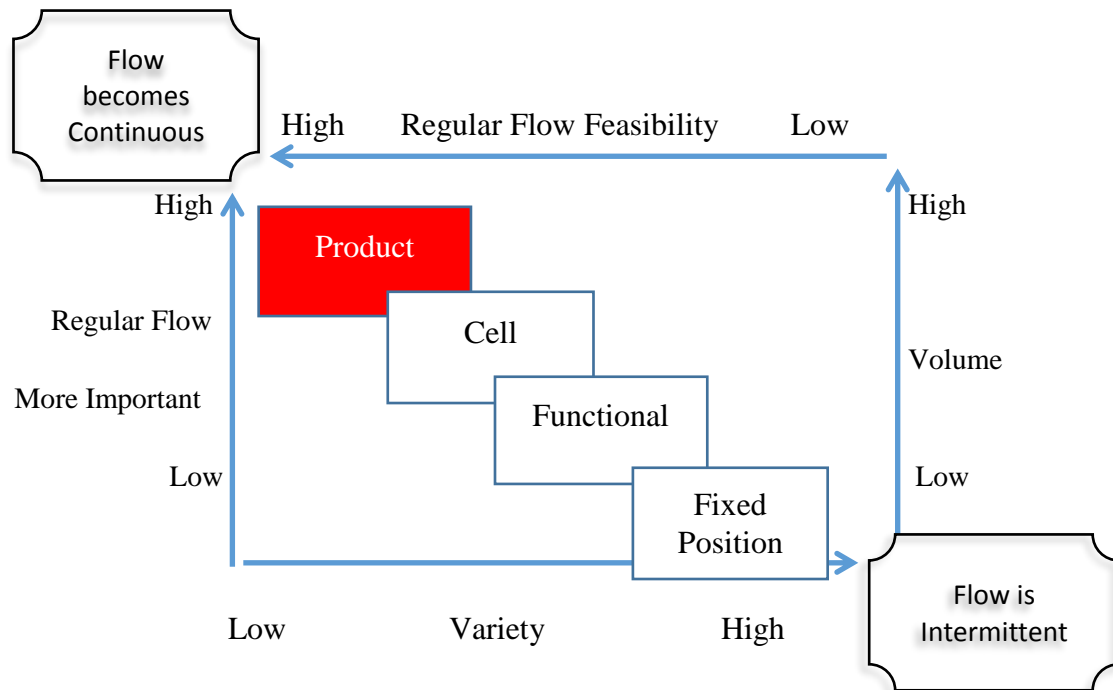
In any manufacturing or service process, efforts are aimed at producing a certain value that meets the needs and expectations of customers. Value is anything that a customer appreciates enough to want to pay for it. It is any capability provided at the right time and price, as defined in each case by a customer to include features of a product or service, availability, cost and performance, etc. (Lean Principles, 2015).

In the case of VRA customers, what constitutes value is power supply and therefore any activity that contributes to its creation, maintenance and delivery is considered as a value-add activity.

Figure 1 illustrates the basic process layout and volume-variety characteristics of VRA's process. It is a product layout type and therefore continuous in nature and highly standardized with very little room for flexibility. With low variety, the main concern is to keep the process running smoothly so that high volumes of power may be produced for constant supply to the customer. This layout is appropriate considering the nature and characteristics of the product VRA manufactures.



Figure 1: Basic Process Layout and Volume-Variety Characteristics



Source: Author's Conceptualization from Data (2017).

Identification of Product Value Stream

Once value is clearly defined by the customer, the next step is for the manufacturer to identify all the activities and tasks necessary to create it. Figure 2 depicts the Value Stream Mapping (VSM) of VRA. It represents company's process of raw material transformation to finished product. At a glance, it is apparent that the various value-add-activities are arranged logically to allow for a smooth material and information flow. This is particularly important because wrong layouts lead to confused flow patterns, customer queues, long process times, increased cost and unpredictable flow (Nigel et al, 2010). In other words, layouts have potential to impact operational efficiency. For this reason, it needs to be given the needed attention.

As depicted in Fig. 2, VRA's VSM involves the acquisition of raw material inputs i.e. Gas, LCO, water, etc. for continuous supply to production units to process into electricity. The electricity is then transmitted continuously to bulk purchasing customers for sale to the end user. Information flows constantly from the customer and supplier to the Chief Executive Officer (CEO) and vice versa. Information also flows from the CEO to and through the Hydro Plant to other production plants and vice versa. There is no limit to production since product flow is continuous.

The Deputy Chief Executive Officer (DCO), Engineering and Operations, manages all these activities (See



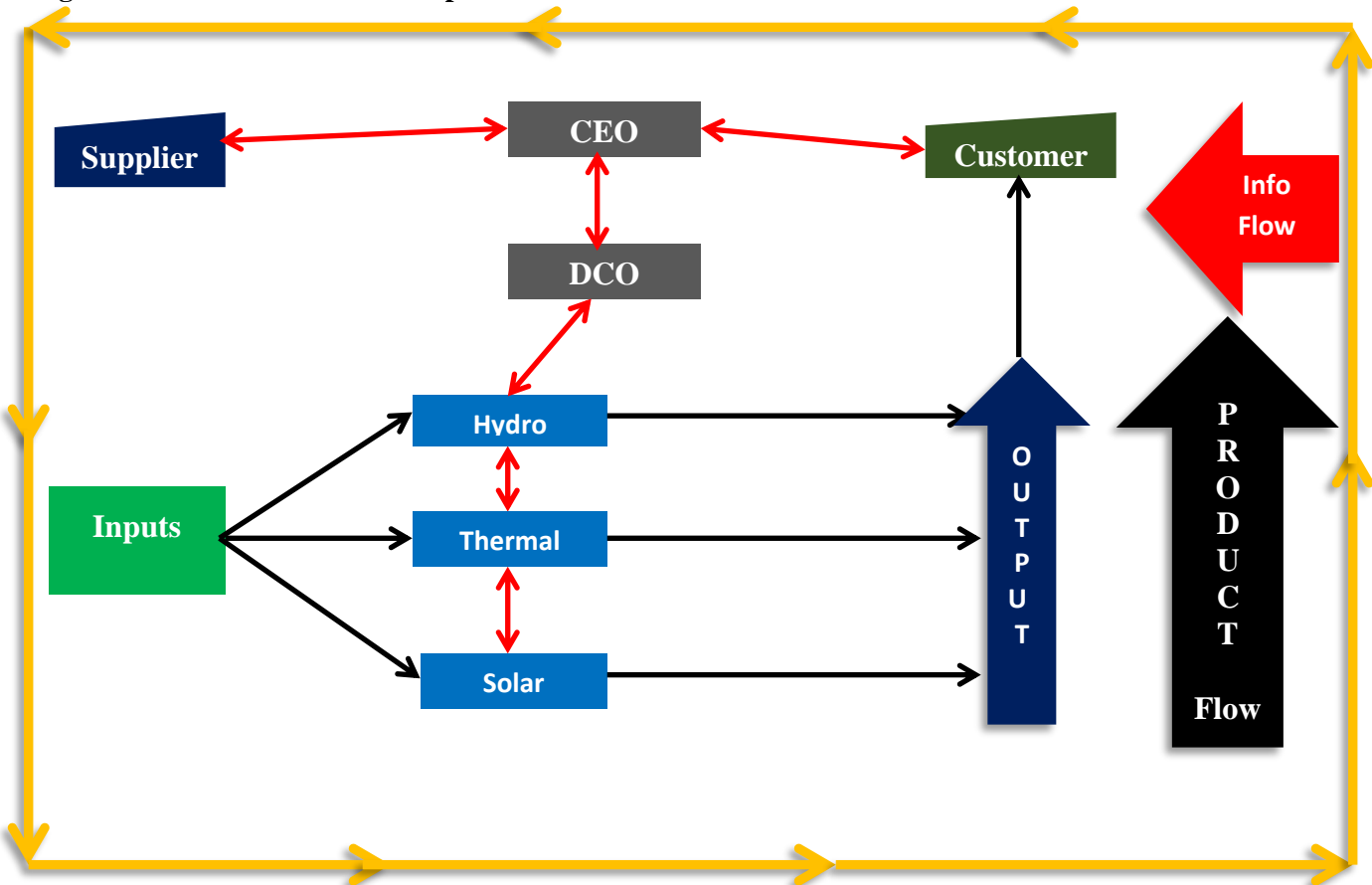
Appendix). It is important that these activities are critically assessed for the purposes of identifying the non-value-add activities. Non-value-add activities are activities or actions that add no real value to a product or service despite consuming time and/or resources (Lean Principles, 2015). Such activities constitute wastage which the effective application of lean techniques remedies through elimination, reduction, integration or simplification. This is the crux of lean thinking. The ensuing paragraphs discuss the non-value-add activities

identifiable in the manufacturing process of VRA as illustrated in Figure 2.

The colour scheme used is interpreted as follows:

- a. ● Black - Product/Material Flow
- b. ● Red - Information Flow
- c. ● Blue - Manufacturing Plants
- d. ● Dark Blue - Output/Product
- e. ● Green - Inputs
- f. ● Gold - Production Timeline

Figure 2: VRA Value Stream Map



Source: Author's Conceptualization from Data (2017).



3.0 Methodology

Without striving for methodological rigour or even logical elegance, the paper was limited to the examination of various documented research papers, periodicals, surveys, news bulletins, financial statements and interviews. Those interviewed included current and former employees of VRA. Explanations from lean principle theorists that had relevance to power manufacturing within the scope of this paper were also used. The researcher believed this blend of data sources provided sufficient relevant data for analysis for the purpose of drawing accurate, consistent and reliable conclusions.

4.0 Discussion and Findings

Unpaid Revenues

The operations of VRA is highly capital intensive. Interestingly, while the company, a public institution, is grappling with inadequate funding from government and lack of credit due to bad credit record, it is owed significant amounts by some of its customers including government through the Electricity Company of Ghana (ECG). The ECG has defaulted in settling its debts in excess of 5 billion cedis to VRA (Citi FM, 2016). As long as these moneys remain unpaid, it constitutes wastage in the form of unutilized assets. Therefore, the VRA must adopt more effective ways of revenue collection and possibly sell only to credit-worthy customers. The recent disconnections exercise embarked on by the ECG, which compelled many defaulters to pay up their debts is good and needs to be sustained (Pulse, 2017). The VRA must bring the needed pressure to bear on the ECG and all other debtors to ensure they pay for the services rendered to them. It must also insist on payment of realistic tariffs for its product while treating transmission and distribution losses as the responsibility of the respective entities accountable. This would minimize wastage and ensure

sufficient capital is available to optimize production to meet demand.

Delayed Information Flow

A cursory look at Figure 2 shows some intermediary role played by the hydro plant. The other production plants depend on the hydro plant to send and receive information. This has an inherent tendency to cause delays and lead to waiting wastage. The time and energy wasted carry with it the possibility of it leading to chaos which would be counter-productive. Therefore, it is important to allow information to flow directly to all plants. Communication at all levels must also be effective to allow for communal information sharing, continuity and the effective dissemination of the company's operational priorities to forestall delays.

Unutilized Stores

At the onset of the country's energy crisis, the VRA procured some power barges to augment production (VRA, 2017). Unfortunately, these barges have been left idle due to the lack of technical expertise to man and maintain them. Not only is the company's capital tied down, the machines are fast deteriorating. They have thus become burdensome and a waste. They are part of the manufacturing set up but are not making any valuable contribution to the product. They thus constitute a waste in the system that need to be remedied. Other stores are similarly held that are not used but incurring expenses by way of storage and care. They may all be sold off completely as appropriate. Relative to the barges, some personnel could be trained and dedicated to its operation and maintenance, depending on their condition at present.



Frequent Meetings, Conferences and Reports

Meetings and Conferences at VRA are rather too frequent and time-consuming. The time and energy translates into wastes in the system. Minutes and reports are regularly written, though hardly complied with; making the time, energy and other resources that went into it wasteful. Brevity, accuracy, clarity and accountability should guide all meetings which should be held infrequently to involve only staff whose presence is actually needed.

Untapped Information Communication Technology (ICT) Potential

Interactions with staff of VRA indicated that most staff are computer literates. However, they bemoaned the fact that the company's operations are largely manual and involve large volumes of printing for communication or documentation. This non-value-add activity is wasteful and increases cost unnecessarily. Efforts should be put into paperless means of communication; with printing done only in exceptional cases where necessary.

Underutilization of Staff

Because the company is performing below capacity, quite a significant number of personnel is dormant or doing very little. The idle time and energy actually emanate from the wait created by the lack of input materials, information, expertise, long approval processes and bureaucracy among others. Whatever the cause, staff inactivity is a cost to the company because the idle personnel still gets paid. The amount represents a waste. Therefore, the company needs to engage all personnel as appropriate productively by ensuring swift information and material flow, regular training, fewer levels and less cumbersome approval process, etc. It may need to

consider laying off all redundant staff to minimize wastage where necessary.

Plant Underutilization

Closely related to the waste arising from personnel redundancy is machinery underutilization. Productive hours and energy are lost to VRA since plants are not usually run at maximum capacity mainly due to lack of inputs. The hydro plant suffers from frequent water shortages (Joy News, 2017). Gas supply to Ghana by WAGP is also erratic (Graphic, 2017). These plants are old and therefore, aside the frequent maintenance requirements, also consumes more fuel and other resources. Their respective contributions to value for the customer are therefore shortchanged. Efforts must therefore be made to always have the requisite material inputs to feed production plants for maximum utilization. Obsolete equipment creates wastage in forms including long processing times, maintenance costs and production losses (Ghana News, 2017). They must therefore be replaced with more efficient modern equipment and sold off for some economic value.

Other Forms of Wastage and Findings

Transporting, sorting and arranging items unnecessarily are non-value-add activities because although time and energy are spent, no contribution is made to value. Examples at VRA are the misplacement of kit and the stockpiling of supplies far from their points of use. Another example is hand-carrying paper work to other locations just to file or get them approved when there is a paperless capability in ICT. To eliminate or reduce this, the benefits of ICT should be embraced fully so that the energy, time and financial assets could be directed at value-add-activities.



Wastage occurring through inefficiencies in transmitting and distributing power in 2012 was over 22 per cent of total power produced (Knoema, 2017). Despite the inefficiencies in the operations of the entities responsible, the VRA has been helpless mainly due to political interference. Therefore, it would be expedient for the company to purge itself of all political affiliations in order to be able to exercise its freedoms and rights in the discharge of its duties. It also needs to rethink its traditions and relationships in order to do away with those identified as unhealthy, restructure some to make them relevant to present circumstances and create new ones that may be necessary for creating and sustaining value to the customer.

The company also needs to make appropriate investments in its operations. This would however only be possible if it focuses on its core mandate and stop making huge investments into ancillary businesses including schools, hospitals and hotels (VRA, 2017). This would ensure appreciable amounts are available to be channelled into actual power generation processes for optimal benefits. Without appropriate investments, it would be impossible to meet the ever increasing demand for power in the country, especially as local generation cost continues to soar. Generation cost in Ghana increases, on average,

between 15-20 per cent per kilowatt per hour in Ghana. However, it costs only 4 per cent across the sub-region (Pulse, 2017). Therefore, it is crucial for VRA to embrace more cost-effective approaches by applying lean techniques to perfect the system. By perfecting the manufacturing system through consistent application of lean principles, wastage will be alleviated or minimized. This would position the company appropriately to effectively deliver on its mandate.

Although some, like Winman (2017), argue that lean manufacturing is disadvantageous because it lacks strategic focus among other things, this assertion is flawed because every company exists for a specific purpose. The fulfillment of that supersedes all other interests, except strategic objectives are redefined to include others. All lean does is exclude all activities that are not aligned to strategic objectives so that it can receive the needed investments by way of time, energy and resources. It therefore cannot be disadvantageous to any company that clearly is objective-driven.

Admittedly, it has limitations and that includes the lack of due consideration for the environment. That however, is not enough to discredit it as an effective tool for cost reduction and quality enhancement.

5.0 Conclusion

The VRA system scenario is characterized by a constant product pull by the customer. The manufacturing process is therefore structured to run continuously to satisfy that. The application of lean principles as discussed will inure to the company's benefit by reducing minimizing or alleviating wastage, This would ultimately lead to increased revenue. Therefore lean philosophy must be embraced by VRA, not as a one off event, but by



consistent application to perfect the system for maximum benefit.

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Appendix

Profile of the Volta River Authority

The Volta River Authority (VRA) was established in April 1961 under the Volta River Development Act 46 to operate mainly as a power generation, transmission and distribution facility (VRA, 2017). Since 2005 however, the Authority's mandate has largely been restricted to electricity generation following a major amendment to the VRA Act. Figure 1 shows how the Authority is organized.

The Authority has several customers. Prominent among them is the Electricity Company of Ghana (ECG) which has over 70 per cent market share and distributes for domestic, industrial and commercial purposes (ECG, 2017). Other customers are AngloGold Ashanti, Newmont Ghana Gold Ltd, Goldfields Ghana Ltd, and Golden Star Resources Group.

Additionally, companies including Aluworks, Akosombo Textile Ltd, Diamond Cement Ghana Ltd and some neighbouring countries such as Togo, Benin and Burkina Faso are all customers of VRA. The VRA has caters for all the afore-mentioned entities with an installed capacity of 2,340 MW out of the total national installed capacity of 4,275MW (VRA, 2017).

The Hydroelectric Power Generation Process involves generating electricity from the Akosombo and Kpong Dams on the Volta River. The dams capture the kinetic energy of flowing water for subsequent conversion into electricity by generators and turbines. The Thermal Power Generation Process on the other hand involves the conversion of heat energy into electric power by using steam-driven turbines to drive electric generators.

The Navrongo Solar Plant is part VRA's Renewable Energy Policy which seeks to develop and operate renewable plants in an efficient, cost effective and environmentally sustainable manner (VRA, 2017). The 2.5MW facility generates power by concentrating the sun's energy to build steam to feed a turbine and generator to produce electricity. Figure 2 depicts the product flow. GRIDCo and NEDCo refer to the Ghana Grid Company Limited and Northern Electricity Distribution Company respectively.

Table 1 shows how VRA generates electricity across its facilities and the respective installed and reliable capacities. The product flow and operational relationship between VRA and other stakeholders in Ghana's Energy Sector are depicted in Figure 2.



Figure 1: Corporate Organizational Structure of VRA (VRA, 2017)

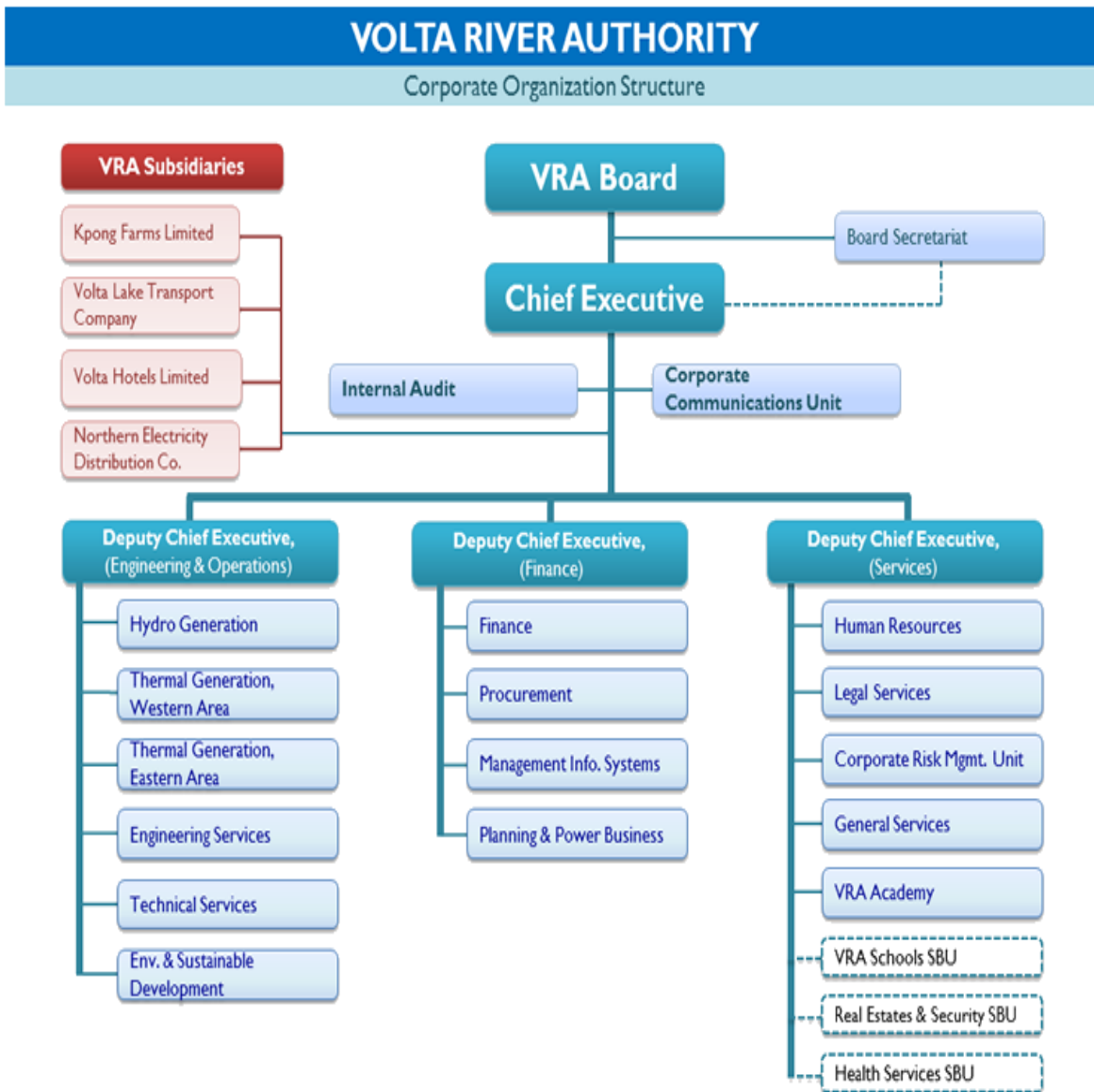




Table 1:
Electricity Generation at VRA (VRA, 2017)

Plant	Installed Capacity(MW)	Dependable Capacity (MW)	Type of Plant	Fuel Type
Akosombo	1,020	900	Hydro	Water
Kpong	160	140	Hydro	Water
TAPCO-T1	330	300	Thermal	Light Crude Oil/Gas
TICO-T2	330	320	Thermal	Light Crude Oil/Gas
Mines Reserve	80	70	Thermal	Gas
Tema TT1P	110	100	Thermal	Light Crude Oil/Gas
Tema TT2P	49.5	45	Thermal	Gas
Kpone	38	32	Thermal	Gas
Kpone	220	200	Thermal	Gas
Navrongo	2.5	-	Solar	Sunlight
Total	2,340	2,107		

Figure 2: Author’s Conceptualization of VRA Product Flow from Sourced Data (2017).

