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College of Business and Economics
School of Commerce
Department of Project Management

**The Challenges of Data Center Project Implementation: The Case of
Commercial Bank of Ethiopia**

By

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Declaration

I hereby declare that the study presented in this thesis entitled “Challenges of IT Data Center Project implementation: The case of Commercial Bank of Ethiopia” is my original work. It had not been presented for a partial fulfillment for any educational qualification at this or any other university and all the resources used for this thesis had been accordingly acknowledged.

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Certification
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This is to certify that the thesis prepared by Girmaw Zeleke Desta, entitled: *The challenges of IT data center project implementation and* submitted in partial fulfillment of the requirements for the Degree of Masters of Art in project Management complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Acronyms

ASHRAE	American Society of Heating Refrigeration and Air-Conditioning Engineers
CBE	Commercial Bank of Ethiopia
DC	Data Centre
DR	Disaster Recovery
EEPCO	Ethiopian Electric Power Corporation
HVAC	Heating, ventilation and air conditioning
ICT	Information and communication Technology
IT	Information Technology
LAN	Local Area Network
MDB	Main Distribution Board
MIM	major incident management
PMO	Project management Office
SDB	Sub Distribution Board
SLA	Service Level Agreement
UPS	Uninterruptable Power Supply
AC	Air Conditioner

Abstract:

In current modern dynamic world, data centers have become very complex and have completely integrated themselves into every aspect of their implied organization. Business organizations require Core banking applications to be available at any part of the day or night. These organizations have realized that with centralized computing and highly available components, their technological presence with customers can be greatly enhanced. Today, many organizations largely depend on projects to achieve their strategic objectives. Accordingly, CBE data center project invested huge capital and tried to implement project. However, the project has faced major challenges during project implementation. The purpose of this study is to identify the challenges of Data center project implementation in the Commercial Bank of Ethiopia. Descriptive research approach is selected for this study. Data were collected for the study using questionnaire, documentation, physical observation and interview. The collected Data was analyzed and interpreted using descriptive analysis technique. The top four challenges are power and cooling challenges, lack of SLA contractors and service providers, management influence on project team site and space decision, and internal constraints or factors that affect the performance and operation of the project. The research findings will give insight for those organizations in Ethiopia which plan to construct new data center by addressing the challenges properly. Based on this finding, recommendations are made to overcome these challenges. This research helps to identify the major challenges in implementation of the data center projects and what constraints are on hand to construct new data Centre in commercial Bank of Ethiopia.

Key Words: *Data Center, IT Data center project, Project Management, Challenges of Data center project implementation*

CHAPTER ONE: INTRODUCTION

1.1. Background of the Study

A data center is a space to house ICT (information and communication technology) equipment as servers, switches, and storage facilities, and to control the environmental conditions (temperature, humidity, and dust) to ensure reliable, consistent, safe, and efficient operation of the ICT systems Rambo & Joshi (2007). A data center is generally organized in rows of racks Kant (2009). Servers can be also housed in a self-contained chassis, which contains own power supply, fans, backplane interconnect, and management infrastructure Kant(2009). A single chassis can house 8 to 16 blade servers Kant (2009). Equipment in data center can be divided in four categories: IT equipment, power equipment, cooling equipment, and miscellaneous component loads, which include lighting and fire protection system. IT equipment includes servers, storage devices and telecom equipment, and supplemental equipment as workstations used to control the center. Main objectives of data center are to store data and provide access to the data when requested.

A data center usually provides different kind of data manipulation technologies and capabilities such as data clustering, data availability, data warehousing and disaster recovery. Data centers are required to support critical business applications by providing the highest level of data availability, integrity, and data consistency economically feasible. Another aspect of data center performance is real time data backup and recovery process, Real-time backup allows data center managers to duplicate their files, directories or volumes without interrupting the work which makes real time backup a better solution for business that cannot effort to have their data systems interrupted or shutdown.

The Data Centre is the focal of any organization - a complex, integrated array of equipment, software and data that drives the business and powers every aspect of its operations. Recent trends show that Data Centre Migration tops the list of key projects for most organizations to meet their future business requirements and keep up with technology. These projects are also undertaken for better financial control as the Data Centre is one of the most financially concentrated assets of any organization. Data Center is core parts for customer, which can provide the place for all of the core devices, servers and storages, and

protects them to keep running properly and to provide the good services for the end users. Data Center plays a key part for the success of the client.

Meskendahl (2010) refers to projects as the central building block used in implementing strategies, therefore business success is determined by the success of the projects. Project success was referred to as reaching the objectives and the planned results in compliance with predetermined conditions of time, cost and performance.

As knowledge in project management field developed, the “golden triangle” was considered not enough to define project success. Project success was recognized to be a complex, multi-dimensional concept encompassing many attributes Pinnington (2014). Base on top of the study and the challenges of reaching project success, in this paper the main aspects related to the challenges of data center project are analyzed.

1.1.1 The Background of the Organization

The commercial bank of Ethiopia was established in 1942. Its previous name during Emperor Haile Silassie was the state Bank of Ethiopia. It was established as Share Company in 1963 and named “Commercial Bank of Ethiopia” CBE profile (2014). Currently, it is one of governmental Enterprises in Ethiopia and it is the only state commercial bank which has great role in conducting Governmental and non-governmental investments and Mega Projects. The commercial Bank of Ethiopia is not known not only in providing Loans but also it is known and pioneer implementer of banking IT technologies. Particularly, CBE invests huge capital for IT projects with intention that it can meet International Banking standards. To comply banking standards and WTO requirements, CBE has been carrying out several IT projects and among these is data center project which is the core for all IT Projects in CBE because every IT based project has servers or stored data access at data center.

The Data Center of Commercial Bank of Ethiopia is required to deliver the ICT services. Data center is the core infrastructure for the Commercial Bank of Ethiopia, since all of the important devices and key business applications are housed in the data center. CBE Data center should provide a highly reliable environment to ensure these devices are able to run properly and provide good services for users. The CBE data center project solution should be esthetic, state-of-art, high-density, robust and secured to meet the needs of the CBE Data Center, and the migration solution should come up with best practice. At the same time, it should keep pace with the industrial trends to be modular and green in infrastructure design and

deployment. The project architecture should help to align data center resources with the Commercial Bank data center.

The principal goals in data center project design are flexibility and scalability, which involve site location, building selection, floor layout, and electrical system design, cooling system, Fire suppression system, security system, mechanical design and modularity (IBM,2006) and (Douglas, 2005). These facilities constructed and accomplished under the CBE data center projects go through complexity to achieve the operational and capacity requirements specified in their initial designs.

Data center project team and DC administrators face dilemma from the initial capacity planning stages of deploying and provisioning new applications, to efficiently allocating resources to meet the application performance guarantees of live systems. At the same time, they must deal with the problems of maintaining the hardware reliability, cooling, and energy needs of running thousands of servers. Data centers require a large amount of planning, interaction with different resources and a large understanding of different areas of expertise to implement from start to finish.

However, Data centers have been required to store an increasing amount of applications and data as archival. Due to modern many redundant services, data centers have not only been forced to grow in size but also in capability, placing pressure on modern data center project and functional managers to maintain smooth operation of the business. CBE has no relatively cost and budget problem compared to other organizations in Ethiopia to invest for building high cost data centers. CBE invested huge cost for Data Centre project to build, relocate, upgrade and improve the performance of business running. As demand and improvement related to cooling system, virtualization, power system and efficiency, redundancy and Disaster recovery increasing and changing, remain challenging. The study focuses on particular challenges related to these systems and designs faced by data Centre projects on two sites; Addis Ababa DC and Kera site DC.

1.2. Statement of the Problem

According to (Huawei,2013) proposals, the data center facilities built and implemented under the CBE data center projects go through difficulty to achieve the effective and capability requirements specified in their initial design. The main objectives in data center project design are capacity flexibility and scalability while implementing the data center project. The project team face problems of maintaining the hardware reliability, cooling, and energy needs of running thousands of server to ensure the business continuity. Data centers involve exhaustive planning, interaction with different resources and a large understanding of diversified knowledge in project implementation.

There is a large amount of cost and time dedication to understand all types of technology and components that must be implemented within a data center. The large amounts of data make it difficult for a user to decipher exactly what components are critical and vital to the success of the project. It is important to design the data center for current organizational needs, yet plan for the growth of the data center to meet the needs of the organizations for the future. in reference to CBE (2014) profile and Huawei (2013) project document, the CBE invested considerable capital for data center to migrate and build data centers with latest possible technologies since project is demanding.

However, the implementation of the data center project has still gaps and difficulties associated with initial design and persistent on its smooth operation. Even though, CBE has made its maximum investment with choice of latest technology and huge capital investment, the implementation of data center project remains challenging and still exist gaps. Therefore, this study has been conducted to identify the challenges in the implementation, a case study of CBE data center project. In particular, the study has answered the questions associated with the major challenges that the project faced on activities related with internal design factors, design consideration and site selection, power and cooling system.

The aim of this study is to identify the challenges concerned in implementation of the data center project in Commercial Bank of Ethiopia. In doing so, the research is to answer the following major research questions:

1.3 Research Questions

On the basis of the problem explained under the statement of the problem section, the research is to resolve about the following basic questions

- 1) What are challenges faced by the project in supplying reliable and efficient power and cooling system?
- 2) What are the challenges related to internal design factors that affect the implementation of the data center? In particular, what are challenges related to disaster recovery, relocation, data migration and redundancy?
- 3) What are factors that limit the project team's preference in deciding space planning and site selection?
- 4) What are challenges associated with service provider and Service Level Agreement(SLA) Contract

1.4 Objectives of the Study

1.4.1. The general objective

The purpose of study was to identify the major challenges in the CBE data Centre project activity and problems faced on its implementation.

1.4.2. The specific objectives

- To identify challenges related to service provider and SLA contract.
- Identifying factors that can affect the cooling and power system efficiency.
- To identify factors that limit space planning and site selection and to address associated challenges.
- To investigate challenges related to disaster recovery, bandwidth, relocation, redundancy and site selection.

1.5. Significance of the Study

Addressing and emphasizing the challenges of CBE data center project will provide a data center owner/manager with a benchmark document that can be used as the departure point for mitigating vulnerabilities, improving reliability and availability, and long term planning or will be used as post knowledge resource for challenges faced by data Centre projects. The study will provide an early warning or historical data source and documentation for countries

like Ethiopia where the technology is not much familiar. It provides insight on how to proceed and what foundations should be built before IT data Centre projects go-ahead.

Planning throughout the entire project of a data center is important as it allows for the correct estimation and scope of the various components supporting the data center. The infrastructure of the data center can allow flexibilities in the system components installed in the data center if planned correctly. The various components from electrical, and heating, ventilation and air conditioning (HVAC) systems installed in a data center are usually modified to provide higher capacities and many organizations could utilize the skills learned in a course offering to provide conscious decisions during projects surrounding their datacenters.

This research will benefit any organization that is looking to build, retrofit, or modify a data center. It will also benefit any institution looking to implement such a course to assist students in understanding major challenges in data center design and major components.

1.6. Scope of the study

This study focused on the identification of the challenges that deter the implementation of CBE IT data center projects at two sites; namely, CBE IT data Centre projects located at Addis Ababa branch (Workama Bank) and Kera site (CBE Gofa Building). The challenges faced will be addressed for all the necessary equipment and system found in these sites. The third data centre proposed at Debre Birhan site was not included on this study because project is new and not launched still now.

1.7. Limitation of the study

The major limitation of the paper is that it was only based on primary and secondary data in the form of questionnaire, observation and documentation with descriptive type of analysis due to short project work period of time even though Data center requires in-depth scientific observation. The constraint of time is the main reason not to use scientific calculations and analytical methodologies used for data Centre equipment. Statistical sampling methods, questionnaire and observation would be used. Collection of primary data on live data Centre system for analytical purpose will not be used and only primary data from observation& questionnaire will be used because of time and cost to use interviews and other scientific measurements.

The secondary data was collected from documents. In this data Centre project implementation, there are other factors beside the challenging factors such as humidity,

altitude and others which affect the overall data Centre project implementation, but all other factors were not be considered in this research because of limited time and other constraints in this advanced technology area that would complicate the study.

1.8. Organization of the Study

The study is organized into four chapters. Chapter one includes: background, statement of the problem, objective of the study, research methodology, significance of the study and scope and limitation of the study. Following on this, chapter two of the study presents reviews of literature on challenges of data Centre projects. Chapter three is concerned with the research design and methodology and Chapter Four is the results and analysis of the study. Finally, Chapter Five deals with summary of the findings, conclusion and recommendations.

1.9. Definition of key terms and Acronyms

- **Data center(DC);**-A data center (DC) is the facility used for housing a large number of computers, the servers themselves, data storages devices, and communications equipment to perform: data management, storing, sharing, processing, and exchange.
- **Project;** -Tayntor (2010) describes a project as a unique, finite set of multiple activities intended to accomplish a specific goal and can be differentiated from other activity by its uniqueness.
- **UPS;** -Uninterruptable Power Supply. It regulates and removes the abnormal factors brought by the mains and supplies pure power to loads. When the mains fail, batteries in a UPS supply power to loads and supplies power devices for 15min-1hour until main supply or Generator takes over.
- **Cooling System;** -the role of data center air-conditioning/cooling systems are to keep the components of the electronic equipment within the manufacturers' specified temperature/humidity range. Electronic equipment in a confined space generates a significant amount of heat, and the equipment's reliability is reduced if it is not adequately cooled. High and low relative humidity levels have also been shown to increase failure rates of electronic components in data centers.
- **Power distribution;** is the power supply source for IT Equipment from EEPCCO (Ethiopian Electric Power Corporation), Generator or UPS.
- **MDB;** -Main Distribution Board

- **SDB;** -Sub Distribution Board
- **LAN;** -Local Area Network
- **Bandwidth;** -the transfer of the data in bytes/sec or Mb/sec
- **Disaster Recovery (DR);** -Businesses and government enterprises utilize Disaster Recovery (DR) systems to minimize data loss as well as the downtime incurred by catastrophic system failures. Current DR mechanisms range from periodic tape backups that are trucked offsite, to continuous synchronous replication of data between geographically separated sites. Typical DR solutions incur high infrastructure costs since they require a secondary data center for each primary site as well as high bandwidth links to secondary sites.
- **Redundancy;** - having the same device or system for fault tolerance or load balancing.
- **Virtualization;** -Virtualization is making one physical machine to have more than one role for cost and data protection purposes. Virtual Data Center (VDC) is a collection of virtual resources (VMs, virtual switches, and virtual routers) connected via virtual links. While a Virtualized Data Center is a physical data center with deployed resource virtualization techniques, a Virtual Data Center is a logical instance of a Virtualized Data Center consisting of a subset of the physical data center resources.
- **Security System;** -Electronical security is necessary to be built up for data center protection. It should be able to prevent unauthorized people entering data center areas using access controls and the site should be monitored 24/7 using video surveillance system. All data center rooms should be controlled by access control systems with different level of security.
- **Fire protection system;** -Data center should have fire detection and alarming systems. An automated fire suppression system should be proposed and the vendor/contractor should design the fire detection, alarming and suppression systems according to the EN or NFPA latest standards. An addition to fire hazard the grounding and lightening protection should be designed properly.
- **Humidity;** -Electronic components have increased failure rates when operating above or below allowable temperature and humidity levels. The (ASHRAE,2011) guidelines recommend a delivery temperature range of 18°C-27°C and a humidity range of 5.5°C dew point to 60% relative humidity and 15°C dew point for data center. Relative

humidity is the ratio of the partial pressure of water vapor in an air-water mixture to the saturated vapor pressure of water at a prescribed temperature. The relative humidity of air depends on temperature and pressure of the system of interest.

- **ASHRAE**; -American Society of Heating Refrigeration and Air-Conditioning Engineers (2011)
- **“Green Data Center”**; -is a repository for the storage, management, and dissemination of data in which the mechanical, lighting, electrical and computer systems are designed for maximum energy efficiency and minimum environmental impact.
- **Information Network Security Agency (INSA)**;—A government agency established with the mission of building a capacity that ensures the country’s security of information and information infrastructures

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Theoretical Overview

Arregoces and Mauricio (2004) state “Data centers house critical computing resources in controlled environments and under centralized management, which enable enterprises to operate around the clock or according to their business needs. These computing resources include mainframes; web and application servers; file and print servers; messaging servers; application software and the operating systems that run them; storage subsystems; and the network infrastructure, additionally, a number of servers support network operations and network-based applications. In this chapter the researcher will discuss some concepts and critical review of empirical studies related to data center project implementation challenges.

2.1.1 Concepts of project

According to Tayntor (2010), project is described as a unique, finite set of multiple activities intended to accomplish a specific goal and can be differentiated from other activity by its uniqueness. Referring PMBOK Guide (2013), it justifies uniqueness of a project,” even though repetitive elements may be present in some project deliverables and activities, this repetition does not change the fundamental, unique characteristics of the project work”. The same writer defined it that the nature of project is finite and time-bounded.

Project management is therefore the art of directing a project. It is important to note that while there are similarities between project and general management, what distinguishes project management from general management is the emphasis on a school and the temporary nature of both the organization and the work being performed.

According to Robert (2011), the IT Project Management Framework is a standardized, objective methodology that assists in identifying, classifying, documenting and managing IT projects. An analysis of weighted factors determines the complexity of an IT project. This analysis results in a project being classified as either a “Basic” project or a project with “Low,” “Medium,” or “High” complexity.

2.1.2 Project Constraints

Managing a project is often described as a supervising work by the project manager to keep all aspects of the project in place concurrently. This concept can be explained in other words as the use of the project constraint triangle. A project is normally both characterized and constrained by three elements: time, resources, and scope. Time is the schedule, resources are people and budget; scope is the functionality to be delivered Tayntor (2010).

When reviewed, the above definition about a data center states the capabilities of technical features in terms of its requirement and support a business or other organization that operates using the services provided by a data center. Moreover, project is unique and finite in its nature designed to meet the intended requirements to deliver outcomes or deliverables. It tells also how project management is practiced by the project manager because project manager is the owner of every unique project conducted.

Alternatively, Chandra (2010) defines data centers and also raises the awareness that terms such as 'server farm' are used in the industry. Moreover, he adds surrounding aspects of a data center in terms of the facility itself to the definition. "a "data center" also called a server farm, is defined as a facility used to house computer systems and associated components, such as telecommunications and storage systems. It generally includes redundant or backup power supplies, redundant data communication connections, environmental controls (e.g., air conditioning, fire suppression) and security devices. Data centers house typical computing resources in controlled environments, managed centrally to enable enterprises to operate according to business needs" (Chandra & Prasad, 2010, p. 129).

The above definitions have one common agreement that a data center's main purpose is to support a business and a data center consists of several critical and supporting facilities and equipment. It consists of the overall aspect regarding the requirements to grant a continuous support of the relying business including managerial, technological, environmental, and security aspects. Therefore, according to (Mukherjee et al., 2010), the management and project construction of a complex structure like the one represented by a data center facility has to take all of the challenges coming from those different areas into consideration in order to provide a maximum support.

Chandra (2010) stresses that the components applicable for a data center consists of its servers, including hardware and software, air conditioning system and energy that is needed to run data center Equipment and battery backup or redundant power supply. Additionally, many physical and virtual network connections operated by capable networking devices, such as routers and switches to provide connectivity are a key component. In addition, the fact of operating the facility at the right temperature and humidity using conditioned air is very critical and challenging issue.

A major challenge for current data centers is an increased demand in strategic operations management that is imposed on them. The increasing complexity of data centers operations lead to an increased amount of campaigns of re-evaluation of investments in terms of day to day sufficiency. This is essential as only the adoption and implementation of the best practices leads to the desired performance of the operation. Furthermore, the complexity of the operation shows that decisions have to be made on all levels of information, and only a combined approach of long term strategies and daily operation processes is suitable to manage a data center. Chandra & Prasad (2010).

As stated by Chandra & Prasad (2010), in my opinion, capacity is important as it affects the costs of the overall data center, and also defines the capabilities of it. Capacity planning has therefore brought into connection with the overall operations strategy, facility planning, and the IT infrastructure planning. It has to be balanced between being able to react quickly to new requirements, thus aiming for flexibility, and the assessment of the extra cost that emerge due to that. The capacity is a factor that is closely related to price/costs. This includes capacity in terms of physical space that is required to run a data center and the capacity of the equipment that is used within the data center.

Space allocation for a data center starts with ensuring that space can be easily reallocated to changing environments and growth. Designers must strike a balance between acceptable initial deployment costs and anticipated space required in the future. The data center should be designed with plenty of flexible” white space,” empty space that can accommodate future racks or cabinets.

The space surrounding the data center must also be considered for future growth and planned for easy annexation standard (TIA-942). This standard deals with facility specifications and recommends specific functional areas, which helps to define equipment placement based

on the standard hierarchical star topology design for regular commercial spaces. Designing data center with these functional areas anticipates growth and helps create an environment where applications and servers can be added and upgraded with minimal downtime and disruption.

Another important aspect critical to data center project implementation is that a data center is a service operations provider. Hence, the various services that have been mentioned in detail in the definitions before are usually provided on the basis of Service Level Agreements (SLAs) that are specified between the participating parties. This is one of external factors that should be considered during and after completion of the data center project for its implementation and described by Wustenhoff (2002) and Mukherjee, et al. (2010) as procedures about what will happen if the provider fails to provide the service, and how the SLA might change over time.

Each of the theoretical literatures highlighted in 2.1 are reviewed in detail in the next section of each sub literatures. The following section of literature review focuses on each of literatures related to the research questions' sub literatures; power system challenges, cooling system, space planning, internal and external factors that affect the implementation of data center projects.

2.1.3 The challenges of power system in data center

In accordance with Hitachi Data Systems (2010), in an effort to have a more efficient data center, the managers are trying to reduce the costs while maintaining intact the availability of the data and meeting the demands of development. However, the reduction of costs would be more effective in combination with decisions which will transform data center functions as well Ebbers et al (2011).

As studies by U.S. Department of Energy (2008) show, the data center equipment's power costs will be more than money spent on the original data center's investment. It is essential for the data center management that the construction and operating costs of the data center are already reduced to the minimum during the design process Greenberg et al (2006).

Data centers require both high-quality and extremely reliable power. According to Bryson et al (2001) and Digital Realty Trust (2007), data centers, telecommunication facilities, and other mission-critical computer systems have the highest costs associated with power outages or lapses in power quality. Data centers almost always have UPS systems to condition

power and eliminate momentary outages, sags, surges, and other deviations from a clean, in-phase AC power.

In this literature, Hitachi Data Systems (2010) concerned about reducing the costs of delivering efficient power to data center maintaining the availability of the data and meeting the demands of future requirement. On other hand, studies by U.S. Department of Energy (2008) show that the data center facilities power costs will be more than money spent on the original data center project investment and Greenberg et al (2006) points out that the necessity of construction and operational costs of the data center during the project design process. The challenge emerges between the above mentioned demands; data center requirement of both high-quality and extremely reliable power and cost reduction.

To resolve these challenges, Normandeau (2011), VanGeet (2011) and Gupta (2011) dictate that correctly designed air management system in combination with strategic investments on equipment could reduce the costs by increasing data center's efficiency simultaneously. Moreover, an efficient data center is a result of managers' attempts to reduce licensing fees, administration costs, floor space costs and storage costs or even trying to increase the income by receiving state's energy funds for implementing green practices VanGeet (2011), Hitachi Data Systems (2010) Ebbers et al (2011), Kant (2009) and Mata-Toledo (2011).

Both the research groups state about the reduction of cost; the first group believes that appropriate in-depth considered project requirement air management design scope in line with strategic project investments on the data center facility could reduce the costs by improving data center's power system performance. It should be clear here that air management design is about cooling system determined or calculated by detail survey of energy dissipation from each equipment and its relationship with surface area of the data center room. The capacity of air conditioners required for data center then proposed in the project design phase. The detail calculations are not the scope of this literature review and it is only about finding out major challenges in delivering efficient and reliable power for the data center.

The other most important critical factors associated with challenges of data center power requirement is redundancy and backup of power supply. Data centers have been designed to allow operational and capacity changes and expansions and in conjunction with the fact that

many of them run redundant power and cooling systems to provide better reliability, the energy consumption inefficiency is quite high Bartholdi (2017) and EU code of conduct (2018).

The challenges are surveyed in the emerging area of data center demand response Data center demand response sits at the intersection of two important societal challenges. First, as ICT becomes increasingly crucial to society, the associated energy demands are skyrocketing (increase rapidly). Second, the integration of renewable energy into the power grid is fundamental for improving sustainability, but causes significant *challenges* for management of the grid that have the potential to increase costs considerably DOE (2008).

According to above researchers *Paolo (2017)*, EU code of conduct (2018) and DOE (2008), data centers often have more than one utility feed and associated seamless or fault-tolerance switching equipment to increase the reliability of service. Battery backup is generally used to provide a short-term outage ride-through of a few minutes to an hour. Longer-term outages are typically handled with standby diesel generators. On-site power generation, whether it is an engine, fuel cell, micro turbine, or other prime mover, supports the need for reliable power by protecting against long-term outages beyond what the UPS and battery systems can provide.

Generator systems that operate continuously provide additional reliability compared to emergency backup generators that must be started up during a utility outage. Backup generators typically take 10 to 30 seconds to pick up load in the case of an outage. The increased reliability provided by continuously operating generator allows for a reduction in the amount of battery backup that is typically designed into premium secure power systems.

Further, this challenge is magnified by the fact that large-scale fast-charging storage is simply not cost-effective. Determining power requirements is based on the desired reliability tier (level consisting redundant source) and may include two or more power feeds from the utility, UPS, multiple circuits to systems and equipment, and on-site generators. Determining power requirements requires careful upfront planning. Estimating power needs involves determining the power required for all existing devices and for devices anticipated in the future. Power requirements must also be estimated for all support equipment such as UPS, generators, conditioning electronics, HVAC, lighting, etc. The power estimation must be made to accommodate required redundancy and future growth.

2.1.4 Data center cooling system challenges

In reference to Allingham (2010), the constant temperature of the IT equipment in data centers is essential that the project and functional managers should implement efficient solutions for the air management of the facilities such as advanced cooling systems. One way this can be achieved is by having a well-designed data center which will not allow the combination of hot and cold air into the system by eliminating the hot spots at the same time Google data centers (2012). A more efficient cooling technique is by using liquid cooling. In that method the purpose of the equipment is racks' wasted heat to be used for a liquid loop in which the highest temperature will be achieved.

In order to reduce data centers, Total Cost of Operating (TOC) managers should take into consideration the improvement of the cooling systems of their facilities since the cooling system can consume 25% or more of the total power. Microsoft (2008), Hitachi Data Systems (2010) and Kant (2009).

Greenberg et al (2006) Studies have shown that by activating the economizer mode in data centers' equipment and by taking advantage of the cold air from the environment outside the facilities, the energy consumption can be reduced to use the cold air from the environment and lowering the cooling costs Cappuccio (2010) and Allingham (2010). There are cases that more than one cooling loops, such as the traditional and hot water cooling loop, have been used in data centers in order to create a more flexible and modular system the green grid (2012). The air management is essential for the functionality of the data centers therefore the temperature and the humidity should be continuously monitored as well as the under floor pressure U.S. Department of Energy (2008).

According to Normandeau (2011) studies, the cooling techniques should be considered as the second most significant area of interest after the design of the data center. The solution of an air economizer can be easily implemented with the existence of a central system which is responsible for the air handling in the facility VanGeet (2011). The existence of a central air system could be essential in the implementation of an optimized air management as a result of the racks' configuration in hot aisle/ cold aisle and the isolation between them as well VanGeet, (2011) and U.S. Department of Energy (2008). Finally, managers should manage to control the temperature of the facilities and the energy consumption of the system by avoiding overcooling as well Microsoft (2008).

The advent of new alternative cooling technologies aims to provide enhancements to HACA (Hot Aisle-Cold aisle) based data centers. Some of these alternatives include in Row Cooling with Hot Aisle Containment Rasmussen (2008), Cold Aisle Containment (Emerson Electric Co. 2008), Overhead Cooling Emerson Electric Co. (2005), and Kool-IT (2007).

In my point of view, the above literatures emphasize about cooling system efficiency and methodology followed by data center project and management. However, in addition to the energy efficiency challenges today air-cooled systems have practical limitations on effectively cooling the electronic equipment in data centers. Because of the low thermal capacity of air, high flow rates are needed to satisfy the cooling needs of the high power density racks. These large flow rates and their accompanied high noise make the data center environment unpleasant for the people working there. Also, the flow rate provided by the CRAC units has an upper practical limit.

On the other hand, according to (ASHRAE, 2011), air conditioning is used to control the temperature and humidity in the data center. ASHRAE's "Thermal Guidelines for Data Processing Environments" recommends a temperature range of 16–24 °C (61–75 °F) and humidity range of 40–55% with a maximum dew point of 15°C as optimal for data center conditions.

The electrical power used heats the air in the data center. Electronic equipment malfunction will be resulted as the ambient temperature will rise unless the heat is removed. By controlling the air temperature, the server components at the board level are kept within the manufacturer's specified temperature/humidity range. Air conditioning systems help control humidity by cooling the return space air below the dew point. Too much humidity and water may begin to condense on internal components. In case of a dry atmosphere, ancillary humidification systems may add water vapor if the humidity is too low, static electricity discharge problems may be resulted and damage components. Subterranean data centers may keep computer equipment cool while expending less energy than conventional designs. Modern data centers try to use economizer cooling, where they use outside air to keep the data center cool.

Referring to ASHRAE's "Thermal Guidelines for Data Processing Environments, data centers across the globe are struggling to free up resources to meet client cooling demands. In order to do this, more control and access to data for optimization of airflow is needed.

Currently, legacy design standards provide more cooling than needed and airflow complexity and IT variability make it difficult to manually optimize with dynamic changes. This results in wasted energy, lost capacity, and hidden thermal risks. The challenge was to improve efficiency in legacy data centers with mixed, multi-generational equipment and to optimize operations through data-driven insights tied to a data center infrastructure management (DCIM) system.

To emphasize more about this ASHRAE's, it recommends detail survey of data center cooling system and humidity otherwise very critical and very expensive data center storage servers and sensitive VISA equipment where billions of dollar transactions stored can be damaged. The challenge emerges on how to survey and identify the relevant parameters and factors of the data center that affect humidity and cooling system indirectly that because damage critical facilities.

Sharma (2008) addressed the importance of cooling, power, and computing in a Data Center with the recent changes to server equipment and design. Every data center air conditioning system has two key functions: to provide the bulk cooling capacity, and to distribute the air to the IT loads. The first function of providing bulk cooling capacity is the same for room, row, and rack-based cooling, namely, that the bulk cooling capacity of the air conditioning system in kilowatts must exhaust the total power load (kW) of the IT equipment.

The various technologies to provide this function are the same whether the cooling system is designed at the room, row, or rack level. The major difference between room, row, and rack-based cooling lies in how they perform the second critical function, distribution of air to the loads. Unlike power distribution, where flow is constrained to wire and clearly visible as part of the design, airflow is only crudely constrained by the room design and the actual air flow is not visible in implementation and varies considerably between different installations. Controlling the airflow is the main objective of the different cooling system design approaches.

Data center is storage and processing of data facility which consists of multiple computer system such as a server, network, storage, switch, and Uninterruptible Power Supply (UPS), and infrastructure. The refrigeration system is a requirement that must be owned by data center. Each electrical device inevitably produces heat and if the device is overheated, the performance of the device will decrease; even it can run into shut down. Each component in the data center has a working temperature during operation, in other words, the components are able to work

well at a certain temperature and components might stop working if it passes the threshold temperature limit.

2.1.5 The challenges related to internal design factors that affect the implementation of data center project

This section of the literature review overviews the challenges associated with the internal design factors that affect the implementation of the data center project.

2.1.5.1 Disaster recovery

Defining disaster recovery requires the definition for disaster recovery site. “A disaster recovery site is a facility an organization can use to recover and restore its technology infrastructure and operations when its primary data center becomes unavailable.” Rouse (2015). To fully utilize a disaster recovery site, the organizations need to establish business impact analysis on their environment along with risk analysis. Based on these two, organizations can produce a working disaster recovery plan. Understanding the impact, identifying critical assets and restoring functions after a disaster, is the main goal when planning for disaster recovery. Cisco Systems, Inc. (2006)

Both of the above writers have a common goal that analyzing business impact and identifying critical resources is required to fully utilize and plan the disaster recovery site. According to Bahan (2003) and Wold (2013), On-site data center redundancy is a way to provide fast recovery from any hardware or software error without the need for disaster recovery. These writers state that the On-site data center redundancy is a real-time data recovery even if there is fault either on the software or hardware.

The main task for Disaster recovery design and planning is to minimize business impact with an acceptable level of risk accepted by the senior management. Calculating return on investment (ROI) is usually the way to get management involved to conduct analysis and therefore justify the planning for continuity and recovery strategies from a technical point of view. The whole background analysis and technical solutions are then tied to the actual business processes by developing strategies for business continuity. The whole process requires training and awareness from the whole organization level as well as making sure the DRP plan evolves along with the business. Periodical testing for all the previously set requirements is the only way to ensure business continuity Martin (2002) and Wold (2013).

Continuity is an essential requirement for all businesses, many examples reveal that the disruption for IT services have a major impact on business functions causing major losses for organizations reputation and revenue Alhazmi & Malaiya (2013). Moreover, the disruption of IT infrastructure can decrease employee productivity and damage customer relationship Nilson, (2006). Many organizations faced difficulties to survive after encountering a serious disaster because they do not have any strategy or contingency plan to contain the damage Shao (2005). On the other hand, many companies continue working without significant interruption as they adopted these emergency plans.

The aim of this study is to reveal the main challenges associated with developing IT disaster recovery plan in organizations. Revealing the challenges will help organizations to gain a better understanding in order to develop this plan effectively, besides uncovering the potential opportunities.

Modern data center infrastructure enables companies robust and maintenance free environment to run their business applications. To keep business running around the clock, new data centers need to be designed in a way that they are reliable, cost effective and flexible in order to meet the business requirements. In addition to running daily services, many companies have turned their sights to disaster recovery (DR) and major incident management (MIM), to ensure no revenue is lost in a case of a disaster.

The above theoretical literatures explain about the importance of designing and planning of disaster recovery, but to achieve this there should be redundancy created for heating, ventilation and air conditioning (HVAC), physical connectivity paths and devices as well as for power and storage which indirectly affect the cost of the data center facility and disaster recovery requires scheduled test on live system which will be risky

2.1.5.2 Virtualization

Virtualization is a method of running multiple independent virtual operating systems on a single physical computer. It is a way of allowing the same amount of processing to occur on fewer servers by increasing server utilization. Instead of operating many servers at low CPU utilization, virtualization combines the processing power onto fewer servers that operate at higher utilization. Virtualization will drastically reduce the number of servers in a data center, reducing required server power and consequently the size of the necessary cooling equipment.

Some overhead is required to implement virtualization, but this is minimal compared to the savings that can be achieved *ASHRAE (2009)*.

In *Energy Efficient Data Center Solutions and Best Practices Cisco (2007)*, addresses how IT professionals can do better design of power and cooling for efficiencies in their data centers through the strategic application technologies and best practices. Virtualization has the promise to maintain or increase computing power and data center performance while controlling costs and extending the value of existing data center facilities. Virtualization enables partitioning, whereby a single physical server runs multiple virtual machines, each with its own.

Due to challenges of rising datacenter expenditure, organizations are now more concerned about environment and energy saving models. Achieving energy efficiency in data centers is a challenging goal and there are large opportunities for savings. These savings will be easy to achieve by addressing the challenges of today's datacenters.

As electricity becomes increasingly expensive due to accelerating demand, there is opportunity to utilize a technology that reduces the power consumption in the data center. Among these technologies, Virtualization is the process of presenting a logical grouping or subset of computing resources so that they can be accessed in ways that give benefits over the original configuration. This new virtual view of the resources is not restricted by the implementation, geographic location or the physical configuration of underlying resources.

Companies can reap instant savings by consolidating underutilized physical data servers onto virtual machines that act like physical computers, but don't require the space, management time or energy of individual servers. Virtualization is replacing the trend of running applications on bare metal servers.

Virtualization lowers costs by sharing compute resources for several purposes instead of using a single server or network application for each function. However, virtualization uses costly technology which is another controversial or contradictory challenge.

2.1.5.3 Bandwidth

As stated on *CAPTOLINE (2017)*, the transmission speeds achieved over a cable are limited by bandwidth. The higher the bandwidth, the more information can be transmitted over the links in definite amount of time. But requires well designed data center network and service provider's bandwidth is decisive factor.

Modern data-center applications, running over networks with unusually high bandwidth and low latency, should have great communication performance. Yet, these applications often experience low throughput and high delay between the front-end user-facing servers and the back-end servers that perform database, storage, and indexing operations. Troubleshooting network performance problems is hard. Existing solutions—like detailed application-level logs or fine-grain packet monitoring—are too expensive to run continuously, and still offer too little insight into where performance problems lie. The rising tide of data-intensive, massive scale cluster computing is creating new challenges for traditional, hierarchical data center networks. In response to this challenge, the research community has begun exploring novel interconnect topologies to provide high bisection bandwidth Al-Fares (2008).

However, these solutions may provide too much—full bisection bandwidth on packet timescales—at too high a cost. In this section, the above articles state about how the information and data transfer is limited by bandwidth. The decisive factors that affect and determine bandwidth are design of the data center network and service provider bandwidth (Ethiotelecom in this study).

2.1.5.4 Power supply redundancy

According to IEEE Standard (446) and (TIA-942) international standards with 2N configuration, stated about the recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications, theoretical concept about power system redundancy is described as follows; the power quality and reliability requirements are expensive, but in data centers, like no other industry, these are paramount, and the extra cost is borne without question. In fact, the power distribution unit is often connected to two parallel UPSs in some data center designs, to provide redundancy for higher availability in case one UPS fails or taken down for maintenance service or repair. In addition to the UPS redundancy, the power supplies in the servers themselves are often redundant, with two or even three power supplies in each server box ready and capable of powering the server completely in case one or more of them fails.

In reference to Xuechao Wang (2014), the typical large data center AC power distribution system is very complex and costly. Because of the reliability requirements of these facilities there are many redundancies, power conversions, paralleling controls, static transfer switches and bypass connections built into the system. It is because of these complexities that a

data center power system is so much more reliable than a typical commercial building power system. It is also because of these complexities that a current day data center power system is very inefficient in both space utilization and energy efficiency.

The impact of these dramatically higher power densities is that, in many cases, power and cooling capacity are the primary constraints to expansion of computational capacity within a data center. As a result, data center managers must either invest in upgrading the power and cooling infrastructures of existing data centers or build new facilities; either choice requires significant capital investment.

2.1.5.5 Cooling system Redundancy

The most important aspect of the HVAC system is the cooling system Alger (2005). Redundancy within the HVAC system provides the ability to continually provide environment regulation in the event of system maintenance or system failures. According to study by Christian Manhood (2009), systems in data center can utilize the cooling systems while maintaining several backend systems. This allows for failover while still providing the same level of service to the environment. Out of cooling system design types, thermal design provides the best way for systems to receive cooled air; however, the end design depends on the facility that is provided. Since the constant temperature of the IT equipment in data centers is essential the managers should implement efficient solutions for the air management of the facilities such as advanced cooling systems Allingham (2010).

2.1.5.6 Server and other devices redundancy

Redundancy is present in all practical storage systems, since it is mostly through redundancy that these systems achieve high reliability, availability, and throughput. Redundancy is typically implemented by replicating the original data. (as in mirrored disk arrays, cluster-based storage systems Petal (1996), or wide-area storage systems or by storing additional information that can be used to reconstruct the original data in case of disk failures.

According Lee (1996) and Mahalingam (2002), redundancy is present in all practical systems because the redundancy is the means in which the data center systems achieve high reliability and availability by replicating original data on additional equipment in case of failure.

However, as redundancy demand increases, the cooling and power system requirement determination becomes uncertain and complex.

As server redundancy demand is increased, there are challenges associated with the power requirement and cooling system. Particularly cooling itself is suffering from redundancy and performance. The power requirement needs upgrading generator, UPS, MDB and raised floor. The data center site selection should be considered much to accommodate such facilities required for future expansion. The project manager should be decision maker, competent and free of bias from top management.

2.1.5.7 Flexibility and availability

The achievement of convergence without affecting the capability is essential for the data centers managers which sooner or later lead to the decision to consolidate of a large part of the IT structure. It can be characterized as a painless decision which can lead to cost reduction from daily operations. Since the efficiency improvement is essential managers should consider wisely implementing initiatives such as server and storage consolidation and availability Miller (2011) and Pfeiffer (2012).

2.1.5.8 Relocation/collocation DC Migration related challenges

According to Ortiz Jr (2006), it requires an exhaustively planning while moving an old data center from original to new location with new facility and data migration. The following are some questions and issues to consider before taking on a data center migration.

- ✓ A project of this magnitude will require a great deal of planning. A data center migration will encompass technical skills, organizational skills, and careful project planning.
- ✓ Inventory of whether which one is obsolete or used again with new system. One possible solution is to use network flow-monitoring tools to get an inventory of applications as-seen rather than as-documented” Ortiz Jr (2006).
- ✓ The move is going to be painful enough without combining it with massive change. Instead, try to keep everything stable for a period of time before the move - a status-freeze Alger (2005).

- ✓ Equipping the new data center with all new equipment introduces significant changes at a time when stability required Taffel (2003).

The location of the data center will greatly affect security, operational efficiency and operating costs. Site criteria should include ensuring that there is reasonable commuting distance for employees, support vendors and other constituents; sufficient site area for parking, water and fuel storage; space for delivery truck access; and a location away from high-risk areas, such as airport-approach corridors, flood plains and areas that are prone to natural disasters, such as earthquakes, tornadoes or hurricanes. Avoid collocating near potentially hazardous areas, such as cafeterias, machine shops, wet labs or other facilities where fires or machine vibrations could present a hazard to data center operations.

Choosing a site that is sufficiently removed from neighboring structures to enhance security. Good setback from main highways or access streets is preferred. If located in a multi tenanted building, look to occupy the ends of the building to minimize disruptions from neighboring tenant. Ensure that the site is adequately serviced for all critical utilities, including power and water. The site plan should provide areas for building and parking lot expansion. However, in CBE the main data center is located near the staff cafeteria, main road and parking is not considered since it is built in the existing building.

2.1.6 The factors that limit the project team's preference in deciding space planning and site selection

2.1.6.1 The nature of data center technology

As the fast growing of business, organizations may have more expectation on data processing, information exchange capacity which provided by data center, so as the data center needs more space, power and cooling to support the IT equipment such as servers, storages, and telecommunication devices Huawei document (2013). The challenges of data center with limited space, limited utility power lead-in, and the increasing energy costs (electricity bill and carbon emission bill) still the most important factors that should have special concern. For a data center operator, any effective energy saving measures will reduce operating expenses and bring considerable economic benefits.

Data centers house servers, and networking and storage equipment, and are considered the central nervous system of the 21st century. They contain comprehensive mechanical and

electrical infrastructures to support the energy intensive computing required to perform one or more of the following functions TschudiW (2004) and LBNL. Definition of data center (2010).

The physical housing of IT equipment such as computers, servers, switches, routers, data storage devices, racks, and related equipment. The storage, management, processing and exchange of digital data. The provision of application services or management for data processing, such as web hosting, internet, intranet and telecommunication.

Capacity is important as it affects the costs of the overall data center, and also defines the capabilities of it. Capacity planning has therefore brought into connection with the overall operations strategy, facility planning, and the IT infrastructure planning. It has to be balanced between being able to react quickly to new requirements, thus aiming for flexibility, and the assessment of the extra cost that emerge due to that Chandra & Prasad (2010). The capacity is a factor that is closely related to price/costs. This includes capacity in terms of physical space that is required to run a data center and the capacity of the equipment that is used within the data center.

2.1.6.2 Constraints of the project manager and project team's roles

According to Taylor (2011), the best PMOs have certain characteristics. These characters are; consistent project management practice; experienced project managers; transparency regarding the project progress and cost, have a clear direction on resource use; openly share information to appropriate stakeholders; flexible in adapting to the strategic expectation of the organization and ability to function effectively within the organization's culture; educational by facilitating knowledge and experience sharing; establish methodologies that can assist the project manager and the project team and committed in quality assurance. Therefore, implementing a PMO is a vital activity and requires commitment from the entire organization.

The main issue in project management is project success. Project success is defined as achieving the project objectives in terms of completing the project within the allocated time period, within the budgeted cost, at the desired performance/technology or specification level, utilizing the assigned resources effectively and efficiently and acceptance by the customer, with minimum or mutually agreed upon scope changes, without disturbing the main work flow of the organization and without changing the corporate culture Kerzner (2009).

In Harold Kerzner (2003) eighth edition the challenges related to Developing Effective Procedural Documentation are stated as; Even though procedural documents can provide all

these benefits, management is often reluctant to implement or fully support a formal project management system.

The introduction of more organizational formality via policies, procedures, and forms might cost money, and additional funding may be needed to support and maintain the system. The system is seen as causing start-up delays by requiring additional project definition before implementation can start. The system is often perceived as stifling creativity and shifting project control from the responsible individual to an impersonal process.

Referring to book edited by Kerzner, the challenges related to top management which thwarts the flexibility in following the project procedure is identified or stated which can also affect the project manager's decisive role. A professional having knowledge and skill to manage the project in limited resources is called project manager. He/she has the responsibility of initiating, planning, executing and closing the project Zahra et al (2014).

Kerzner (2013) pointed out that project management is successful due to its methodological approach of process integration, process creativity, effective planning, execution, supervising and control, and lastly closure to accomplished completed projects.

2.1.6 The challenges associated with service provider and SLA Contract

2.1.6.1 SLA Definition and Theoretical Overview

According to international Journal of Grid Distribution Computing (2015), researchers defined "Service Level Agreement" as a format that contains an explanation of the agreed service, parameters of the level of service, the guarantees regarding the Quality of Service, and arrangements for all cases of violations. The SLA is very significant as a contract that is held between the provider of the service and another party who could be one of following; consumer of the service, broker negotiator, or monitoring negotiator.

So this contract determines, commonly in quantifiable terms, the services that the service provider will provide and what sanction the Service Provider will pay if the dedicated objectives cannot be met. SLA has been applied in a multiplicity of domains that are related to IT such as: Web Services, Networking, Internet, and Data Centre Management.

DeAssuncao (2006) states that the most summarized SLA contains generic and technical terms such as; business endings, pricing strategy, and attributes of the resources needed to operate the service.

In accordance with “Sun Microsystems, Service Level Agreement in the Data Center” (2010), an appropriate SLA puts borders and prospects for service supplying and delivers the following advantages:

- **Improved customer acceptance level:** SLA enlarges the customer approval level, as it supports providers to concentrate on the customer needs and confirms that the work is placed on the right way
- **Enhanced relationship between the parties:** SLA specifies the payment and payback policies of the service provided. The consumer can examine services according to Service Level Objectives (SLO) determined in the SLA.
- **Enhanced Service Quality (QoS: Quality of Services):** The actual performance values are compared with the stated ones in the contract to make performance reports used for evaluation Frey (2013).
- **Performance:** is defined by the response time QoS metric which refers to the maximum time that the request treatment can take from the time of storage, and the arrival of the response.

On the other hand, major incident management (MIM) is all about handling situations that are out from the normal operating procedures. Well documented and trained MIM process helps companies revert to normal operations in a swift manner. Usually MIM refers to the organizations existing SLA (service-level agreement) agreements about the necessary recovery point objective and recovery time objective England (2014) and Nolting (2013).

As stated England (2014) and Nolting (2013), the SLA contract agreement is required to restore and recover services into normal state. In this, SLA and service provider is the most important factor in success and smooth operation of the data center. In Ethiopia, there is shortage of domestic professional service, service provider organizations and spare parts and the study will look in-depth this challenge.

2.2 Empirical review of the literature

The fundamental nature of this part of the literature review is designed to find the research gap that will be related to inclusion or omission of certain independent variables, the strength of the methodology that can be adopted or adapted, measure the conformance or disconformance of the findings of the study with other findings.

An empirical study on the challenges of the IT data center projects has not as much of well reported. Researches related to this particular study are reviewed as follows;

The study carried out by Papadopoulos & Wurm (2012) determined that data center managers have decided that the performance of their Data centers should be reported in terms of Power Usage Effectiveness (PUE) which is a metric that have been developed by Green Grid Haas & Froedge (2009).PUE is the ratio of the Total Amount of Energy Used in a data center divided by the IT Energy Load of the data center and this measure can be used to help managers reduce the energy used for non-computing procedures such as cooling and distribution of power in the data center (Hunter & Sandberg, 2010; Hughes & Tschudi, 2011; Google data centers, 2012). Moreover, it should be mentioned that the value of the PUE is dynamic and can be affected by different factors such as temperature and equipment changes (Microsoft, 2008).

The data centers' UPS systems are being backed up by engine-generators in case of power failure. The minimization of power distribution losses in the facilities is essential and it could be achieved by avoiding unnecessary power conversion steps Google data centers (2012) and Kant (2009). The standby energy losses of these generators are significant and it should be addressed by minimizing the amount of generators which are in standby mode Greenberg et al (2006) and VanGeet (2011).

Moreover, the energy consumption can be reduced by right-sizing the central plants as well as the system responsible for the ventilation which will result to an efficient operation of the facility Greenberg et al (2006). Additionally, the contribution to the energy consumption of the equipment's placement on the floor can be essential as well Allingham (2010).

According to Chandra (2010), A major challenge for current data centers is an increased demand in strategic operations management that is imposed on them. The increasing complexity of data centers operations lead to an increased amount of campaigns of re-evaluation of investments in terms of day to day sufficiency. Therefore, as demand and

complexity of data center increases, the power requirement determination is challenging in dynamic environment.

Maximizing the usage of a facility's peak power capacity while simultaneously reducing the risk of exceeding it is a difficult problem but a very important part of managing the costs of any large-scale deployment.

On the other hand, according to Franz (2005), deducing power consumption in data centers involves a number of facets including: (a) low power hardware design, (b) restructuring of software to reduce power consumption (c) exploitation of various power states available in hardware, and (d) proper design, usage and control of data center infrastructure. This complicates that design and capacity consideration of the data center power system.

From this study, it is possible to conclude that as complexity and demand increases, the power requirement decision is challenging because many variables affected. Among these as number of equipment increase, the power dissipation increases in addition to power requirement. Power dissipation affects cooling system and humidity of the data center. Furthermore, design consideration should be reconsidered and which will be difficult on live system.

From the Timothy Wood (2011) study show that data centers face challenges from the initial capacity planning stages of deploying and provisioning new applications, to efficiently allocating resources to meet the application performance guarantees of live systems. At the same time, they must deal with the problems of maintaining the hardware reliability, cooling, and energy needs of running thousands of servers.

All of these issues are compounded by both the massive scale of modern data centers and the fast paced workload dynamics of many data center applications. Administrators first must deal with infrastructure challenges such as determining data center architectures and providing sufficient cooling and power for large numbers of servers. According to Timothy wood (2011) it was found also that data center managers faced with challenges of saving energy because many project managers give priority on the initial or upfront costs not energy saving plan or project.

This agrees with theoretical literature by Anderson (2001) which states that the increasing energy consumption of data centers is a growing concern, and work is being done in the "green computing" area to better manage the power and cooling systems in data centers.

According to Zhang.Qi(2007) data center operators must deal with the deployment and planning problems related to estimating a data center's capacity and initial provisioning for new applications.

Again from the same study conducted by Timothy Wood (2011), disaster recovery solutions incur high infrastructure costs since they require a secondary data center for each primary site as well as high bandwidth links to secondary sites. From this, cost and bandwidth links are factors for the disaster recovery challenges because it requires resource replication, well design and bandwidth which can backup or take over when there is fault on the main (live) data center in real-time. Additionally, further, the "larger" the potential impact of a disaster, the greater is the need for geographic separation between the primary and the secondary replica site. The resulting wide area latency can, however, place a large burden on performance.

The study conducted by Papadopoulos (2012) states that the main pressure or challenge comes from its customers who need smooth performance, storage and access of the data. The data center should have SLA with its customers. This helps in determining the maximum time in which agreed services interrupted. But in CBE case, the most critical SLA is with external service providers of infrastructures; power and telecom services. Also, as reviewed in the above literature the data center is a service provider and should sign SLA with its customers because the data center shouldn't be interrupted even for few minutes. The availability and reliability are variables of SLA contract.

According to Singh (2009) several project or program management implementation challenges were identified. Among these, the challenges relevant to this study were identified: these are

- ✓ Rigid corporate culture and failure to manage organizational resistance to change
- ✓ Lack of experienced project managers and PMO leadership
- ✓ Failure to design a PMO around a company's specific needs
- ✓ Lack of full support of the senior management and various stakeholders to the PMO
- ✓ Role, authority, and responsibility of the PMO is poorly defined or understood
- ✓ Difficulty in evaluating the effectiveness of PMO in the organization

- ✓ Lack of training and communication on PMO implementation to all stakeholders
- ✓ Difficulty in staffing PMO with most experienced personnel

According to the Study conducted by Alnaji (2014) identified project management office challenges which include: selected relevant to this study are

- PMO is not empowered to make needed decisions
- Lack of a defined project management methodology
- Project managers not managing all aspects of projects
- Project managers managing several projects simultaneously
- Lack of executive and top management support
- Ad-hoc projects prioritization and tasks assignments
- PMO is only being a process controller and regulator
- Rigid project management methodology
- Not tracking project's resources hours and utilization

2.3 conceptual relationship and conclusions of the literature review

According to Chandra (2010), demand and complexity of data center increases, the power requirement determination is challenging in dynamic environment. The servers and other ICT equipment generate heat at increasingly high density and then require suitable environment conditions of cooling and power system to remain within certain ranges to operate and reduce failure risk.

The demand for critical equipment and complexity results because each system in the data center is interrelated. This study shows that the challenging factors to determine power and cooling system in data center dynamic environment are demand and complexity. On the other hand, in this study, it was found also that data center managers faced with challenges of saving energy because many project managers give priority on the initial or upfront costs not energy saving plan or project.

The servers and other ICT equipment within datacenters create heat - and at increasingly high densities. At the same time, servers also require their environmental conditions to remain within certain ranges in order to operate effectively and reduce the risk of server failure. These environmental parameters, and others such as air particulates and gaseous pollution, are set by the capabilities of the server hardware installed in a data center.

However, for the majority of data centers, optimizing energy consumption and setting an appropriate environmental operating envelope is complicated and depends on a web of inter-related factors. These all have an effect on the overall PUE and total cost of ownership and the right balance has to be struck depending on the type of datacenter, its location and the resilience/capabilities of the hardware housed within it.

In 2004 ASHRAE published their first set of 'Thermal Guidelines' for data centers. The guidelines represent recommended and 'allowable' parameters for temperature and relative humidity, based on an assessment of the latest tolerances of computer hardware. Since 2004 ASHRAE have published new iterations (2008 and 2011) as hardware has become tolerant to broader ranges of environmental conditions. One of ASHRAE's guiding principles in the publication of this work is to help drive efficiency whilst maintaining data centre reliability.

Based on ASHRAE (2011) analysis and standard, the data center project faces frequent failure of storage server hard disk and corrosion on humidifier filter spare parts. There should be an environmental factor or site selection and design problems which create gaps in successfully completed project. The location of the site on the ground has challenges with Rodents and some flood leakages of the building. Physical security system is another gap which must be raised here as difficulty related to site selection.

Modern data-center applications, running over networks with unusually high bandwidth and low latency, should have great communication performance. In data center project case, there is additional challenging factor due to bottlenecks of service provider and limitation of bandwidth Quota for project organization. Service provider itself provider may be suffering from bandwidth limitation as demand for service is increasing aggressively all over the country or world.

Hi-tech that improves bandwidth performance like fiber, dark fiber etc is very limited and approval for provision can be possible through negotiation through board of directors and Government. Because of this limitation and poor performance of data center bandwidth, it will 1-2 hours to run a single transaction from the branches located in a country and overseas. The performance and speed of transaction execution between branches are affected by bandwidth provided by service provider.

Generally, bandwidth service is major factor for difficulties in poor performance of data centers. The second reason can be professional incompetence of contractor or project team to

configure and optimize all the necessary equipment that can affect the performance. As number of servers and new branches added, the network traffic is congested which directly affects the performance of data center speed and results in degraded the bandwidth. This challenge is associated with line bandwidth limitation or the future capacity of data center is not well designed.

The study by Timothy Wood (2011) concluded that disaster recovery cost for secondary data center and band links due to geographic separation of the two sites are challenging constraints. In Ethiopia where only one monopolistic telecom exists, this should be investigated more because there is limitation of band width links and dark fibers.

This study by Salama and Alnaji (2011) explained indirectly that the authority of the project manager and project are constrained by challenges listed above in which the project team cannot prefer space planning and site selection flexibly. The first line among lists of challenges emphasizes about the project team whereas the second describes about the project management procedure and methodology. The last one above lists insights the rigidity of project methodology as constraint that thwarts the flexibility of the project team decision to select sites and location according to international standards and design. The best practice in the world to determine distance between disaster recovery and main data center is 138-150km.

To summarize theoretical and empirical literatures discussed and reviewed before, a conceptual framework is developed for this study.

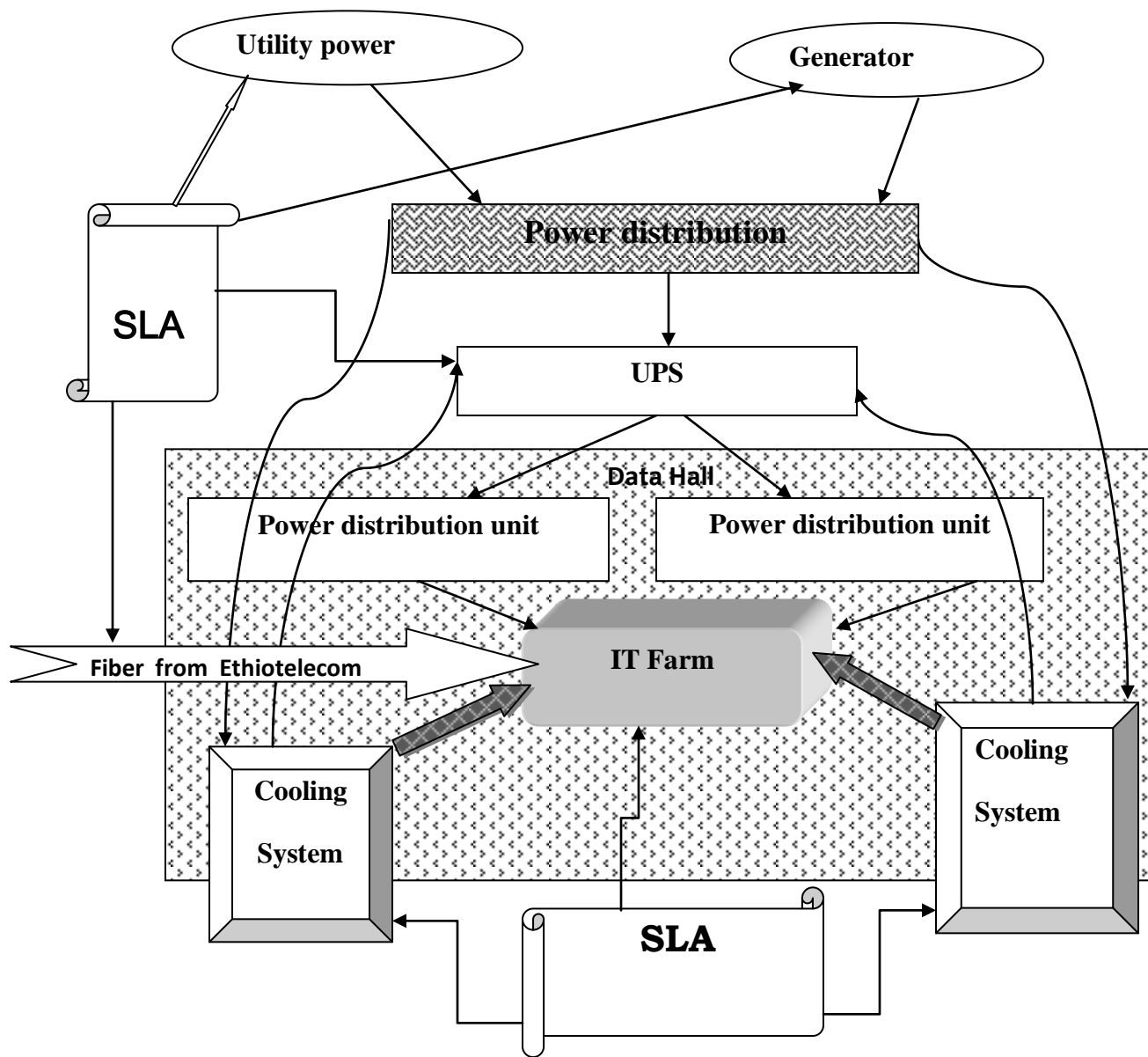


Figure 2.1 logical diagrams to develop conceptual relationship of the data center constraints and challenges.

Source: developed from Pearl *Hu* (2003)

Based on the theoretical, empirical and above diagram, the conceptual relationship/framework between factors and related challenges is developed is developed as;

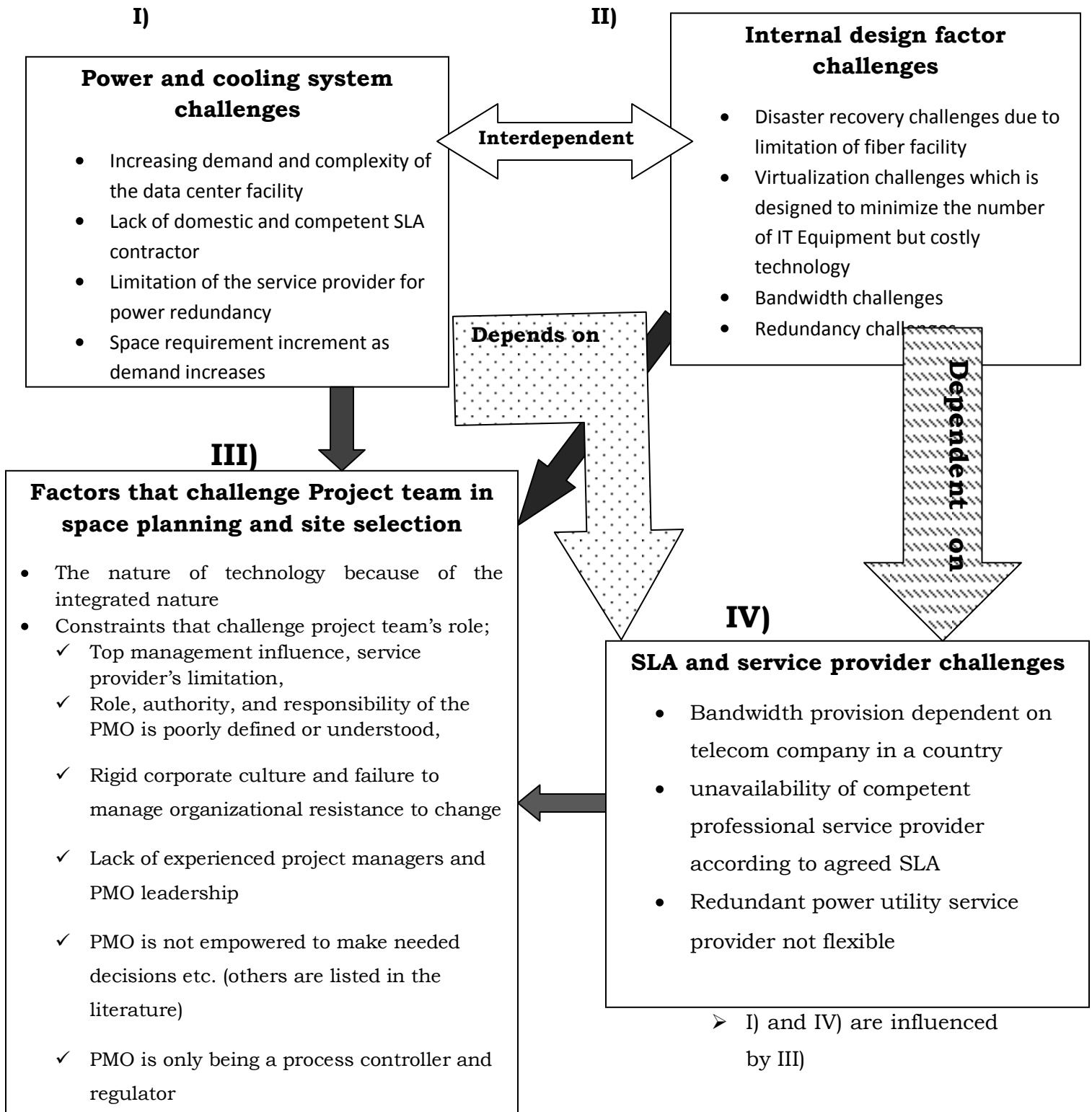


Figure 2.2 Source; conceptual Framework developed from theoretical and empirical literature review above

CHAPTER THREE

Research Design and Methodology

This section outlines how the study was conducted. It focuses on research design, data source, target population, sampling, data types, techniques, data collection tools and data analysis that will be used in this study.

3.1 Research Design

The research designs are plans and procedures for researches that range cover decisions from broad assumptions to detailed methods of data collection and analysis Crosswel (2009). The approach used in this study will be qualitative approach which makes descriptive method more reliable.

3.2 Population and Sample Size

Target population is defined as the entire group of individuals or objects to which researchers are interested in generalizing the conclusions Castillo (2009). For this study, the target populations are all CBE IT project team who participated in the project, managers, Team leaders, senior infrastructure team, DC Technicians and all data center staffs who are administering and monitoring its performance at both sites. The total number of infrastructure related project and functional staff are 100. Thus, for this study, the target population is 100. The target population is taken based on the number of staffs who have involved in the CBE IT project and infrastructure staffs.

3.3 Sampling Techniques and Procedures

The basic assumption behind purposive non-probability sampling is that with sound judgment about the purpose of inquiry or questionnaire, the researcher can categorically select relevant respondent and cases. A purposive non-random sampling method is used in the current study. Half of target population is considered as a source of primary data from DC Administrators or staffs and project staffs of CBE. Fifty percent are considered because these are directly involved in CBE IT data center project during project activity and implementation

and experienced infrastructure staffs are also selected and remaining others are mostly business staffs that have no technical skill and knowledge about infrastructure of IT projects. Also, most are distributed to their previous sections after project is completed

3.4 Source of data and collection methods

3.4.1 Source of data

The main sources of data in this study are categorized into primary and secondary data sources and direct observation and interviews. The primary data sources are selected data center project and functional staffs. The secondary sources of data are obtained from project documents and proposals. For the descriptive type of researches primary data are obtained through semi-structured questionnaire survey and direct observation& interviews. To conduct the study, semi-structured questionnaires are employed to obtain the required data from selected sample respondents. The questionnaires are prepared in English language.

3.4.2 Instrumentation for Data Collection

The primary data collection instruments are questionnaire designed, interviews and observation. The following data collection methods are included in this study.

3.4.2.1 Questionnaires

Data collection tools that will be used in this study are questionnaires, which were semi-structured and enabled the researcher to collect qualitative data. The questionnaire is adopted from HR and IT questionnaire templates. The researcher developed the questionnaire based on the objectives of the study. This involves open-ended questions.

3.4.2.2 Observation and Interviews

The data can be collected through site visit and communicating the key professionals face-to-face and reviewing important problems documented.

3.5 Document Analysis

In addition to the primary data, documentary evidence such as data policies, minutes of meeting, project proposals, project design document, project contract document, books, articles and other related resources are used to supplement the study.

3.6. Ethics and Code of conduct

The researcher places a due care in collecting and analyzing data as a means to assure the accuracy of results. Additionally, the researcher also keeps the confidentiality of the respondents. In line with this, the researcher does not analyze the data's that contradicts to the reflection of the respondents. They are given the chance to ask any thing about the study and informed and made free to refuse or stop the questionnaire or interview at any moment they want if that was their choice.

3.7. Data analysis and presentation

A qualitative data analysis allows describing a phenomenon from different direction through holistic approach. The features of qualitative data indicate its diverse nature and there is no standardized procedure for analysis. Despite this, the collected data need to be reduced, displayed in graphical, tabular, percentage and finally concluded or verified in the analysis process Sanders et al (2009) also explained the data analysis process in the form of summarizing (condensation) meanings; categorization (grouping) of meanings; structuring (ordering) of meanings using narrative are groups in the analysis process.

In addition, these issues were examined from the challenges of the IT data center projects. Lastly, the challenges were ranked based on the questionnaire response and top challenges of the IT data center project implementation were identified. Therefore, based on Cresswell (2009) the results will be presented in descriptive and narrative form, tables, graphs and charts.

CHAPTER FOUR

Results and Discussion

This section of the chapter presents the findings from the data collected through questionnaire, observation and documentation. The chapter starts with presenting the major findings obtained from the questionnaire, documentation and observation concerning the data center project. It particularly discussed about the challenges of planning space and site selection, power and cooling systems, project team authority and internal factors that affect the performance.

The qualitative data that was collected through questionnaire survey, documentation and observation was analyzed to answer the research questions and to meet the research objectives set in chapter one of this study. The general and specific objectives of the research were to identify the challenges of IT data center project implementation in a Commercial Bank of Ethiopia; to identify the major challenges and emphasize related factors that complicate the data center projects. Accordingly, this chapter begins by discussing the findings about the nature, components and construction of data center and then goes on with the findings of the research objectives.

4.1. General Overview of the CBE IT Data Center Project

Based on observation conducted by researcher, the general overview of CBE data center is described to give general illustration of the project. The CBE data center was proposed and designed to meet the business and the technical requirements of the Commercial Bank of Ethiopia. Before project implementation, CBE data center was only one and very small with only two servers located at Addis Ababa Branch (Workama Building). In 2005 G.C, the disaster recovery site was constructed at Kera site containing only two servers with some Cisco devices.

In reference to CBE profile (2014), the CBE start to initiate the data center projects to modernize data center facility after the government declared the transformation policy and BPR (Business Process Re-engineering) all over the country. CBE was one of governmental

enterprises which implemented BPR (Business Process Re-engineering) even though the process was not successful. The data centers were constructed at sites and totally co-located and constructed from scratch with latest technologies consisting of many servers, storages, CISCO core switches, cooling and power systems, fire protection and security systems and other facilities. The New DC at Addis Ababa Workama building site was co-located on the existing site. The Kera site new DC was co-located from second floor of the Kera building to Ground.

CBE program office supervises currently three data center projects; Addis Ababa site upgrading, Kera site 3rd module expansion and feasibility study to construct data center at Debrebirhan. The scope of this study focuses on the two sites; Addis Ababa and Kera sites with projects previously completed and undergoing upgrades. The projects were constructed by CBE project staff and Huawei in collaboration with INSA (3rd party) as consultant or facilitator.

4.2 Analysis and discussion on Primary Data

The primary data are collected through questionnaires, distributed to sample employees of data center project and functional staffs, other senior IT staffs, PMO staffs and IT audits.

4.2.1 Analysis and Discussion on Data Collected through questionnaire

Fifty questionnaires were prepared and distributed to Data center administrators and managers, Senior CBE IT staffs; IT Audits and PMO staff of DC and other IT projects and 50 questionnaires (100%) were responded.

Questionnaires based on four research questions designed for challenges in data center project were analyzed using descriptive analysis with the help of SPSS and excel. The result of the survey for each research questionnaire is analyzed with corresponding tables (From table 2-6) in the following section: -

Table 4.1 Profile of the Respondents

Status information	category	Frequency	Percent
<i>Position of respondents</i>	Data center project staff	4	8
	Project manager	2	4
	DC Administrator	7	14
	Senior data center Administrator	2	4
	Network administrator	15	30
	Others (experts, IT officer, IT Auditor, senior district support, team leaders, PMO technical staff etc.)	20	40
<i>Educational Level</i>	PHD	0	0
	Diploma	0	0
	MSC/MA	2	4
	BA/BSC	48	96
	Other	0	0
<i>Years of Experience</i>	1-3	5	10
	4-7	26	52
	8-12	3	6
	13-15	4	8
	Above 15	12	24

All of the above statuses of the respondents are important to answer questionnaires because all of positions indicate that they have good knowledge and know-how in data center projects, educational level is all BSC and MSC and finally, most are experienced in IT area. Generally, profile of the respondents is relevant to the questionnaire and the title of the paper.

4.2.2 Analysis based on primary data collected for the four major research Questions

Tables 4.2: Questionnaire analysis about challenges in supplying reliable and efficient power and cooling system. This table shows the number (frequency) and percent for data collected from 50 respondents

Questions	Ratings(response options)	Frequency(number of respondents)	Percent (%)
ACs are Operated at full load on both sites	Yes	13	26
	No	27	74
As the number of equipment in the data center increase , the degree of increase in the power consumption for power and cooling system	Low	0	0
	medium	3	6
	high	45	90

	Very high	2	4
	Proportionate	0	0
Period to get service	Long	43	86
	medium	3	6
	short	4	8
Quality of SLA	Good	13	26
	poor	37	74
	Fair	0	0
Avaliability of the suppliers that provide professional support and spare parts	Low	35	70
	medium	10	20
	High	5	10
	Very High	0	0
In case of main data center failure, disaster recovery site can take over all the branches of CBE within	Real time	13	26
	One hour	0	0
	Cannot handle all	37	74
	More than one hour	0	0
Cost of EthioTelecom bandwidth provided for data center	Fair	10	20
	low	0	0
	high	7	14
	Very high	33	66

This table shows the analysis on challenges of power and cooling system in data center project

The following lists of challenges are found based on the level of respondent frequency expressed in percent and Average value is taken for similar options.

- 90% responded that as the number of equipment in the data center increase, the degree of increase in the power consumption for power and cooling system is high.
- 74% responded “no” that ACs are Operated at full load on both sites which is related to power shortage challenges
- Avaliability of the suppliers that provide professional support and spare parts.74% responded “Low”
- 80% responded that Cost of EthioTelecom bandwidth provided for data center is high
- The period within which to get service or line from EEPKO.86% responded” Long”

- How would you rate the quality of SLA providers of the Cooling System.74% responded poor quality.
- In case of main data center failure, disaster recovery site can take over all the branches of CBE within.74% responded “cannot handle all”
- Cost of ethiotelecom bandwidth provided for data center is responded very highly 66% of respondents
- 70% responded “Low” on availability of the suppliers that provide professional support and spare parts

Table 4.3 Analysis of questionnaire on challenges related to internal design factors

Questions	Frequency (%)			
	Strongly agree	Agree	Disagree	Strongly disagree
Redundancy of all the software or equipment is mirrored or have the same performance at both sites	0	34%	66%	0
Virtualization saves power and cooling system cost or expense	14%	86%	0	0
Virtualization requires high skill and advanced technology	34%	66%	0	0
Branches at Juba and Djibouti can access T24 application from data center in Addis Ababa	24%	6%	56%	14%
Ethiotelecom can provide fast services like fiber and dark fiber without any difficulties within the schedule of the project	0	54%	46%	0
CBE can choose DC site anywhere in the country	6%	20%	60%	14%
DR site of the CBE data center is selected without influence of top management and ethiotelecom service availability	6%	14%	80%	0
Unavailability of alternative or different private /government Telecommunication is a challenge to construct the data center project	34%	60%	6%	0

From analysis shown on this table on challenges due to internal factors, identified challenges from the table are;

- Redundancy of all the software or equipment is mirrored or have the same performance at both sites.66% responded “No”
- All (100%) agreed that Virtualization requires high skill and advanced technology and saves power consumption
- 70% responded that branches at Juba and Djibouti can access T24 application from data center in Addis Ababa

- Ethio telecom can provide fast services like fiber and dark fiber without any difficulties within the schedule of the project.94% responded” disagree”
- CBE can choose DC site anywhere in the country.74% responded “disagree”
- DR site of the CBE data center is selected without influence of top management and ethio telecom service availability.94% responded “disagree”
- Unavailability of alternative or different private /government Telecommunication is a challenge to construct the data center project.94% of participants agreed upon it

Tables 4.4 questionnaire Analysis about constraints that limit the project team’s preference in deciding space planning and site selection

Questions	Rating(response options)	Frequency	Percent (%)
Does the site location for data center project professionally selected and designed	Yes	10	20
	No	40	80
who decided the site location	contractor	0	0
	CBE project management	17	34
	CBE top management	30	60
	other	3	6
Does site selection meet international standards related to raised floor, cabling space sufficiency and space for additional cooling and power system	Above Requirement	0	0
	Meets project Requirement	23	46
	Below Requirement	27	54
	Other	0	0
Considering flooding, Rodents, fire and security safety, how can you explain the degree of safety	Very Safe	17	34
	Safe	13	28
	Medium	13	28
	Low	7	14
	Other	0	0
What is the reason that site selection is below requirement	Selection is made by management	47	94
	The floor selected is not enough	0	0
	Not properly designed	3	6
	Other	0	0
In principle, Disaster recovery and main data center should be located in separate place. Where are these sites located in	Different Cities	15	30
	Different place but the same city	35	70
	The same place	0	0
	<i>Different country</i>	0	0
Who did choose these locations of disaster	CBE management	40	80

Questions	Rating(response options)	Frequency	Percent (%)
Does the site location for data center project professionally selected and designed	Yes	10	20
	No	40	80
who decided the site location	contractor	0	0
	CBE project management	17	34
	CBE top management	30	60
	Project staff	10	20
	contractor	0	0
	Other	0	0
The distance between disaster recovery site and main data center is determined based on best practices	Agree	10	20
	Strongly Agree	2	4
	Disagree	30	60
	Strongly Disagree	8	16
The world best practices and distance between CBE DR and DC sites is	7km	3	6
	100-150km	47	94
	1000km	0	0
How would you rate the availability of certified or professionally competent Companies that provide SLA service in Ethiopia	Very high	0	0
	high	0	0
	medium	3	6
	low	37	74
	Very Low	10	20
The dark fiber service and power redundancy service requests from respective service providers are negotiated at level of	Project manager	3	6
	Director	10	20
	Board of director	34	68
	Functional manager	3	6
How would you rate the quality of SLA providers of the Cooling System	Excellent	0	0
	good	4	8
	Fair	6	12
	poor	40	80
The cost of providing power source from two different substations	Less Expensive	2	4
	Expensive	10	20
	More Expensive	36	72
	Most expensive	2	4

Analysis in the above table shows the following findings;

- ❖ 80% of the project team responded that disaster recovery location is highly influenced by management to decide site selection and space determination
- ❖ Because of top management influence, the site selected in the same city. Best practices recommend that the distance between two sites should be 100km-150km. But CBE data

center is below 10km or 94% responded the distance between DR and Live DC is below 10km.

- ❖ The current location has major challenges which affect performance of data center; it is located on ground which is vulnerable to flooding and rodents
- ❖ 80% responded that there are Environmental factors that affect project implementation
- ❖ In principle, Disaster recovery and main data center should be located in separate place. Where are these sites located in.70% responded in different places but the same city.
- ❖ 98% responded that the cost of providing power source from two different substations is expensive
- ❖ How would you rate the availability of certified or professionally competent Companies that provide SLA service in Ethiopia.94% responded “Low”
- ❖ 90% responded “No” that site selection is done based on professional recommendation

Table 4.5 Analysis of questionnaire designed about challenges associated with service provider and SLA Contract

Questions	Frequency (%)			
	Agree	Disagree	Strongly Disagree	Strongly
<i>Ethiotelecom can provide high performance bandwidth services like fiber or dark fiber Technology flexibly</i>	10%	80%	0	10%
<i>fiber ring service can be obtained at any place of Ethiopian territory</i>	20%	80%	0	0
<i>It cannot be said the bandwidth service and disaster recovery are redundant since there is no alternative or another telecom service in a country</i>	88%	6%	0	6%
<i>EEPCO can provide redundant utility power source any time it is requested</i>	6%	80%	0	14%
<i>It is difficult to get redundant utility power from two separate substations</i>	68%	26%	0	6%
<i>spare parts for cooling system and other DC facility can be obtained easily</i>	10%	74%	9%	7%
<i>CBE Data center can obtain the bandwidth service from service provider other than Ethiotelecom</i>	0	86%	10%	4%
<i>Companies which signed SLA agreement for data center cooling and power facility project are strong and internationally competent</i>	10%	76%	14%	0

From above table (4.5), the analysis shows the following responses;

- 80% responded ‘No’ that Ethiotelecom can provide high performance bandwidth services like fiber or dark fiber Technology flexibly and can be obtained anywhere.

- EEPCO can provide redundant utility power source any time it is requested.80% responded “disagree”
- 74% responded disagree that to get power from separate substations
- 86% responded “disagree” that CBE can obtain bandwidth other than ethiotelecom
- 90% responded “disagree” that Companies which signed SLA agreement for data center cooling and power facility project are strong and internationally competent.
- It cannot be said the bandwidth service and disaster recovery are redundant since there is no alternative or another telecom service in a country.88% responded “Agree”

Table 4.6 Analysis of findings rated as the opinion or perceptions about the overall challenges of the data center project. This table incorporates questionnaires for all four research questions to increase accuracy and minimize bias.

1=Strongly Disagree (SD) 2=Disagree (D) 3=neither Agree nor Disagree (And) 4=Agree (A) 5=Strongly Agree(SA)

No	Opinions	Frequency (%) or percent				
		1	2	3	4	5
1)	The site selection of data center is chosen and designed based on CBE requirements of the project	28%	0	6%	40%	26%
2)	The data center project has faced challenges during its project activities and after implementation	12%	0	0	74%	14%
3)	The disaster recovery can take over main data center in real time in case of failure	14%	34%	0	32%	20%
4)	It is safe that both sites of data center are at ground floor	0	14%	26%	20%	40%
5)	The CBE project’s standards of cable labeling & layout space, raise floor, location of design, space for expansion in the future meets International standards of data center at both sites.	6%	54%	6%	14%	20%
6)	EEPCO provides redundant utility from different substations within specified schedule	6%	62%	0	26%	6%
7)	Ethiotelecom has capacity to provide any requested size of bandwidth within a project schedule	20%	48%	6%	20%	6%
8)	CBE project depends on EEPCO and ethiotelecom for service provision	6%	0	0	54%	40%
9)	Ethiotelecom is flexible to provide dark fiber and high fiber widths anywhere in Ethiopia	14%	60%	0	26%	0
10)	The management decided the location of project site	14%	54%	0	6%	26%
11)	The 3 rd party or consultant is awarded the data center bid through competition or through legal process of selecting best bidder	6%	14%	14%	40%	26%
12)	The power utility can support all ACs at the same time and utility power is supplied from two different substations	0	60%	20%	14%	6%
13)	The cooling system faces challenges of performance	0	6%	14%	40%	40%
14)	Management bias on cost minimization is one of bottleneck to choose best standards	0	6%	26%	26%	42%

No	Opinions	Frequency (%) or percent				
		1	2	3	4	5
15)	Data center migration both physical and data movement can be done with high professional skill and competence	0	34%	14%	26%	26%
16)	The CBE project staff is qualified to do the project without participation of the contractor/bidder	6%	78%	6%	14%	6%
17)	The 3 rd party or INSA has capability to do the project without participation of contractor	14%	66%	0	14%	6%
18)	The rodent system, fire protection and security system meet the requirements of CBE and international standard	54%	20%	0	20%	6%
19)	Both sites of data center are chosen at location no or minimum risk will occur if there is flooding	54%	14%	26%	6%	0
20)	The redundancy of space on sub distribution board, space cabling through raised floor, cooling capacity is well considered for future expansion	0	60%	20%	6%	14%
21)	Project manager is free of management influence to decide about the project site location	0	60%	20%	14%	6%
22)	CBE data center network designed to provide service for oversea branches like Juba,Dijubuti and there is no need of satellite or VSAT network	6%	74%	14%	6%	0

In the table 4.6 above, 21 questions were analyzed. This table incorporates opinions related to all four research questions. This table was added in the questionnaire to increase accuracy and to minimize biases and errors which might be encountered in the above analysis done on tables 4.2-4.5 for each research question. Accordingly, the analysis shows the following findings relevant to challenges

- Cooling and power systems challenges
- Contracting party professional incompetence
- Redundancy and space planning are limited by service providers (Ethiotelecom and EEPCO)
- Top management influence on project team in decision making
- Site selected is challenging on the performance of the data center project because of flood, vehicles, cafeteria fire and rodents
- The data center network is not flexible to implement the core banking overseas because of the band width limitation and performance of Ethiotelecom
- The supplier selected offers poor quality equipment because the top management is biased on minimum cost

- The project staff is technically incompetent because of the nature technology is new and dynamic to predict and plan
- The project procedure is modeled in Traditional project management PMLC and IT projects should be modeled as agile projects.
- Due to inflexible project decisions, the future space requirement and cable is not well considered

Table 4.7. Analysis of the challenges related to top management influence and logistic. This section was prepared for both interview of the project manager or and as questionnaire for all respondents.

1=very dissatisfied, 2=some what dissatisfied,3=neutral,4=somewhat satisfied,5=very satisfied

No.	Opinions	Frequency(%) or percent				
		1	2	3	4	5
1)	Working in the live environment during data Centre upgrading project has no critical Impact on overall system.	40%	30%	14%	10%	6%
2)	During project implementation, for every live action, it requires change advisory board (CAB) approval.	0	0	0	20%	80%
3)	The unavailability of domestic/local Companies who can Provide Professional support and spare parts are a bottleneck in data center Project success and implementation.	0	6%	0	14%	80%
4)	Delay of goods and service due to poor logistic system and unavailability of local suppliers is challenging and creates behind the schedule for success of project within project schedule	0	6%	6%	20%	78%
5)	Too minimum down time is allowed to implement New projects by top management and creates behind schedule then associated project parameters like cost and time trade-off occurs.	0	6%	6%	14%	74%

The following found to be major challenges related to Logistic, managerial decisions and working in live system while upgrading and constructing new data center project. These questions were prepared for project manager as interview and questionnaire for others.

To sum up the challenges in this section;

- Down time decision for every single activity of project requires CAB approval which in turn affects project schedule

- The lack or shortage of Local technology, spare parts or service providers is a major challenge in African countries in general
- Delay of equipment shipment due to poor logistic system and unavailability technology and spare parts providers locally
- Down time allowed is too short to accomplish the planned work

Data center migration from existing to new location or same location is challenging because it is risky to work on live system and down time affects the overall performance of the business organization.

4.2.3 The summary of findings and discussion on data collected and analyzed both from primary and secondary data source

According to analysis and findings from both primary and secondary data source in chapter four, the following major challenges were identified and summarized

1) The power and cooling system challenge identification and findings

- As the number of equipment in the data center increase, the power and cooling system requirement increases.
- The Ethiopian electric power corporation cannot provide the power redundant from different substation flexibly and within the project schedule. The limitation of redundancy determines to supply reliable power to data center
- The unavailability of local service providers and SLA contractors domestically is challenging to get the spare parts for air conditioners and other systems
- The professional service providers and SLA contracting organizations in the country are poor quality in their service they deliver. They cannot provide spare parts on time and professionally incompetent. Their financial potential is low and also they are few in number.

2) challenges related to internal design factors

- The band width is limited because ethiotelecom has no full coverage for fiber ring to provide reliable high speed service anywhere in the country. This limitation challenges the free site selection, indirectly the space planning.
- Virtualization reduces the power and cooling utilization since several services run in one physical devices but the challenge is it requires advanced technology and skill.

- Disaster recovery site selection and flexibility depends on Ethio Telecom. Hence fiber ring and high speed reliable dark fiber limited coverage is a major challenge to select the DR site at different city in a distance of more than 100km.
- The top management influence on project team in selecting site and space is a challenge to plan space utilization for the current and future demand. Space planning and design then affects the standards of cabling. This poses challenge in laying out the power and data cable separately. The space planning also determines free flow of air within raised floor.
- Migrating the data center from old to new location is a major challenge because it needs high skill, technology and down time of the business
- Unavailability of alternative or different private /government Telecommunication is a challenge to construct the data center project.
- Cost of ethiotelecom bandwidth provided for data center is responded very high
- The data center is not flexible due to telecom limitation to access Core Banking application (T24) on branches located in overseas; Djibouti, Juba and others.
- The supplier selected offers poor quality equipment because the top management is biased on minimum cost
- The project staff is technically incompetent because of the nature technology is new and dynamic to predict and plan
- The project procedure is modeled in Traditional project management PMLC because of rigidity in top management decision
- Due to inflexible project decisions, the future space requirement and cabling is not well considered
- Site selected is challenging on the performance of the data center project because of flood, vehicles, cafeteria fire and rodents

3) **Challenges identified associated with constraints that limit the project team's preference in deciding space planning and site selection**

- ✓ The project team is highly influenced by management to decide site selection and space determination and also mentioned in cooling and power system challenges (no.1 above). This space limitation is a major challenge since demand of expansion

exceeds the space determined during design of project and strategic business requirement is dynamic from time to time

- ✓ Due to limitation, the project team forced to select the location within Addis Ababa which is not feasible when risk is considered. It also affects the space planning for future present and future expansion.
- ✓ Because of top management influence, the site selected in the same city. Best practices recommend that the distance between two sites should be 100km-150km. But the distance between CBE data centers is below 10km due to influence of top management and telecom limitation
- ✓ The current location has major challenges which affect performance of data center; it is located on ground which is vulnerable to flooding and rodents

4) Challenges Related to Service providers and SLA Contract

- ❖ Service providers (Ethiotelecom and EEPCO) provision is limited and costly, and also it is negotiated at high level of management, it affects the three constraints or trade-offs of the project scope particularly schedule.
- ❖ The data center is mission critical environment and technology which requires redundancy of power source but as findings show it is rare and difficult to get power source from separate substations within project schedule
- ❖ The Ethio telecom fiber coverage is low and not found every where
- ❖ Unavailability of SLA contracting companies and service providers is comprehensive challenge in data center project implementation
- ❖ Scarcity of spare parts because most not found in the country
- ❖ Redundancy and space planning are limited by service providers (Ethiotelecom and EEPCO)
- ❖ The data center network is not flexible to implement the core banking overseas because of the band width limitation and performance of Ethiotelecom

5) Challenges identified from Interview, observation and secondary source

- ☑ **Limited Space;** Due to unavailability of high speed bandwidth ethiotelecom fiber flexibly and Influence of the top management, the CBE data centers are constructed under the old buildings in the same city which do have limited space for expansion

- ☑ **Limited power Lead-in;** Data Center needs more than 550KVA power source from different substations. Limitation of power distribution in a country is a challenge.
- ☑ **The increasing Energy costs;** Electric power costs both for Diesel, and EEPCO source and unavailability of cheap, clean energy from sunlight and wind is another challenge.
- ☑ Migrating from second floor of existing data center to new on the ground
- ☑ Unavailability of local spare part suppliers and SLA contractors
- ☑ Too minimum down time to test the project pilot phase and working on live system is risky due to lack of redundancy environment
- ☑ Power and Ethio telecom limitation to provide service flexibly and within the project schedule

CHAPTER FIVE

Summary, Conclusion and Recommendation

In this section of the paper, the researcher sets the objectives of identifying the challenges in data center implementation in CBE and stating the recommendations based on data analysis and forwarding recommendations based on findings. This chapter provides the conclusion to the study and forwards recommendations

5.1 Summary of the major findings

The purpose of this study was to identify the challenges of the data center project implementation in the Commercial Bank of Ethiopia. Therefore, the Self-administered questionnaires designed for fifty respondents, direct observation of DC and one project manager was interviewed to collect the primary data. Semi structured interviewees with key informants who were Key data center administrators were also important contact personnel during observation of the data center. During direct observation, pictures were taken up and inspection of all the system done to show or identify the difference about the data center before and after the project and also important information regarding the data center challenges were collected. All the findings were analyzed in chapter four of this study. The secondary data was collected through reviewing and in-depth review of the project contract documents, project proposals prepared by Huawei and INSA. All these documents were provided by project manager for this study in both soft and hard copy.

All these data collection instruments were used to identify challenges associated with power and cooling system, site selection and space planning, internal constraints that determine the performance of the data center and challenges related to service provider and SLA availability. The approach used in this study was qualitative research approach which used descriptive type of research.

According to analysis and findings from both primary and secondary data source in chapter four, the following major challenges were identified and summarized. The following major findings of challenges associated with each research questions and objectives were identified. These are challenges that predominately affect the DC project implementation which are related to power and cooling challenges, internal design factors, space and site selection challenges and Service Level agreement. Therefore, the summary of major findings is described in accordance with each challenge questions.

- ☒ The power and cooling system challenges are mainly associated with that as demand of DC equipment is increasing, the power and cooling system power consumption increases. Second, the limitation of EEPCO to supply redundant power supply from different substation flexibly and within the project schedule. Third, the unavailability of local service providers and SLA contractors domestically is challenging to get the spare parts for air conditioners and other systems. Finally, the professional service providers and SLA contracting organizations in the country are poor quality in their service they deliver.
- ☒ The internal design factors that affect the data center project implementation are limited bandwidth due to low coverage of ethiotelecom to provide dark fiber and fiber ring, disaster recovery is not selected flexibly by project team due to top management influence and bandwidth limitation, DC migration and virtualization of devices requires high skill and technology. Furthermore, the top management influence on project team in selecting site and space is a challenge to plan space utilization for the current and future demand.
- ☒ The major Challenges identified associated with constraints that limit the project team's preference in deciding space planning and site selection are; first, the project team is highly influenced by management to decide site selection and space determination and also mentioned in cooling and power system challenges as mentioned above. This space limitation is a major challenge since demand of expansion exceeds the space determined during design of project and strategic business requirement is dynamic from time to time. Second, due to bandwidth limitation and management influence, the project team forced to select the location

within Addis Ababa which is not feasible when risk is considered. It also affects the space planning for future present and future expansion.

- ☒ Because of top management influence, the site selected in the same city. Best practices recommend that the distance between two sites should be 100km-150km. But the distance between CBE data centers is below 10km due to influence of top management and telecom limitation. Additionally, the current location has major challenges which affect performance of data center; it is located on ground which is vulnerable to flooding and rodents
- ☒ Major findings of challenges related to Service providers and SLA Contract are; unavailability of domestic SLA contractors, poor quality of service provision by ethiotelecom, EEPCO and SLA contractors, scarcity of spare parts and cost of these services is high and expensive.
- ☒ Unavailability of local spare parts, delay in service provision, increasing energy costs like for diesel, limited space design, and too minimum down time to test the project pilot phase and working on live system is risky due to lack of redundant environment.

5.2 Conclusion

Knowing the challenges that are hindering the implementation of the data center project helps to address the root causes and major difficulties of IT data center projects during project life cycle and operation. This can help to insight and early precautions in constructing data centers especially in Ethiopia where there is only one power corporation and telecom services. Furthermore, shortage of SLA contractors and domestic professional service providers is another bottleneck for such new data center industry projects.

Even though the data center power and network facilities are redundant, the two governmental monopolistic companies; EEPCO and Ethio telecom limit the redundancy of utility power and bandwidth flexibility respectively.

Therefore, based on the above summary of the major findings and categorized respective to each research question, it can be concluded that the following are the most challenging issues selected and concluded in this study.

- ✓ While power and cooling challenges considered, it can be concluded that as server redundancy demand is increased, there are challenges associated with the power requirement and cooling system. Particularly cooling also has challenges associated with lack of spare parts and dynamic demand for devices. The power requirement needs upgrading generator, UPS, MDB and raised floor. The data center site selection was not considered much to accommodate such facilities required for future expansion. These interrelated factors complicate the challenges faced on the implementation of the data center project and the research study or survey focused and made conclusions on findings for CBE case that the data center has challenges with utility power redundancy and Lack in availability of capable domestic companies that provide spare parts and professional support is another major challenge for data center operation and business continuity.
- ✓ The major challenges in selecting the data center sites is due to factors; first, the Ethio telecom fastest speed services like dark fiber cannot be provided flexibly anywhere in Ethiopia. Second, the project manager and his team have no full authority and influenced by top management to select the right site that meets the international standards.
- ✓ Disaster recovery design and preparation is another part of data center that faces challenges and influenced by the same factors of site selection and bandwidth limitation. It requires well designed LAN network in addition to the bandwidth size provided by Ethio telecom and server mirroring or redundancy of the devices
- ✓ In connection with Challenges of space planning and site selection findings, it was found that the space requirement is limited or influenced by constraints; first, lack of following the project procedure by project team and free to act and empowering the project staff to decide and select the site, lack of flexible service provider and SLA contractor, top management intervention and the nature of the technology. The nature of technology means in this case dynamic as demand increases. The program office does not follow the project procedure due to managerial incompetence and influence of top management. The top management decision is influenced on other hand by 3rd party service providers and lack of consultants that can enforce the management to follow the international standards.
- ✓ In concluding findings of space determination, data center space requirement faces challenges to determine the specified space. As the demand for critical IT Equipment

increases, the challenge to determine and plan the space increases because the data center technology is integrated which requires increase in other systems.

- ✓ According to analysis of primary data from questionnaire responded and direct observation, CBE data center project faced the major challenges related to SLA and service provider. In findings section of this study, the data center systems lack the availability, flexibility and quality of service during the project implementation. The major service providers in Ethiopia considered were EEPCO and Ethio telecom. First, the data center requires the redundant utility power from separate substation. This was challenging for the implementation of the data center project.
- ✓ The other service provider which has major impact on the implementation of CBE data center project is Ethio telecom. The service provided by ethio telecom for data center is bandwidth. Ethio telecom is the only telecom company on which the DC network depends that CBE has no choice except negotiate with stated price. Similarly, like power issue, ethio telecom has limitation with bandwidth. In addition to limitation, the area of coverage for fiber optics ring is the other challenge.
- ✓ Data center requires fastest speed in data transfer with low congestion. In doing so, it needs bandwidth using dark fiber or higher size of band width but limited and challenging to get easily and anywhere. This service provision determines the site selection for data center construction because such dark fiber or size of bandwidth from fiber optics technology is not found in every town or location of Ethiopia. Therefore, it is challenging issue for data center performance and choice of location.
- ✓ The SLA contract is another determining factor for the implementation of the project that the project requires transfer of risk for 3rd party for provisional service and provision of spare parts during the project activity and business operation. Most of the data center systems need SLA contract between CBE and supplier. According to analysis of questionnaire and documents regarding SLA from data center management, the major challenges in this aspect are unavailability of professionally competent service providers, poor service quality and shortage of spare parts locally.

5.3 Recommendation

Based on the study findings, the following recommendations are in sighted;

- ☑ The advanced technology projects like data center should focus on intensive training and development of in-house staff since there is deficiency and inefficiency of SLA contract binding companies which can take the risk transferred as 3rd party for professional support and supplying spare parts.
- ☑ There should be no top management influence in site selection and design of the data center and the project team should decide the site and space planning by forecasting future demand.
- ☑ The data center should have designed considering its dynamic nature of the technology
- ☑ The project team and the sponsor organization should implement the project procedures according to project principles.
- ☑ Program management office should use its authority and professional discipline to decide site selection and implement project procedure properly.
- ☑ The international data center standards should be followed while designing and implementing the data center project.
- ☑ The project methodology or model for data center projects should be other than traditional project management since the nature of technology and strategic demand is dynamic.
- ☑ The training and development should be major part of the project to empower the project team
- ☑ The 3rd party selection should be based on international bid to obtain competent consultants and suppliers. The usual trend in CBE case is that INSA takes every logistic, consultancy and commissioning part of all the CBE IT projects with direct intervention and command of the government. INSA is not capable agency and does these activities only to have practice in IT technology to control financial transactions.
- ☑ SLA contracting organizations should be selected based on competitive market or international bid.

- ☑ The data center project requires reliable and redundant power supply. It should be considered seriously before starting the project implementation and it should be part of survey and feasibility study.
- ☑ Internal network design should be with professionals who are internationally certified and Local area bandwidth should be maximized to compromise ethiotelecom and until there exists alternative Telecom
- ☑ Generally, site selection and space planning power, telecom and SLA service providers are more important factors that considerably affect the data center project schedule and cost so that more attention should be given by project manager and project sponsoring organization or body.

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Appendix

Addis Ababa University

School of Commerce

Department of Project Management

Dear Respondent

The purpose of this questionnaire is to collect primary data for a senior essay prepared in partial fulfillment of the requirement Masters of project Management in Addis Ababa University. The senior paper is on the challenges of CBE IT data center project implementation. The questionnaire below will assist in identifying area of challenges of project implementation for enterprise Data center. The AAU and the Researcher would like to thank all respondent that take their valuable time to fill the questionnaire.

Your response to this survey project would be strictly confidential and data from this project will be included in the report in the aggregate.

Remark: please respond to this item frankly, honestly and your feedback is vital to the successful completion of the research. There is no need of writing your names on the questionnaire, put tick mark and if necessary explain.

I. Questionnaire

1. Personal profile

1.1. Position of respondent: -----

Data center project staff

Senior data center Administrator

Project manager

DC Administrator

Network administrator

Other please specify.....

1.2. Please can you tell us your educational level or qualification on your field of study?

- PHD
- Diploma
- MSC/ MA
- BA/BSC
- Other certificate

1.3. How many Years you have been working in CBE?

- 1-3
- 4-7
- 8-12
- 13-15
- Above 15

1. Questionnaires about the challenges faced by the project in supplying reliable and efficient power and cooling system

1.1. Does overall power distribution redundancy fulfill for data center?

Yes No

1.2. Do both data centers have redundant path of power after change over switch panel ?

Yes No

1.3. Referring 1.2 is cabling for power and data laid out through **conduit/trunk** in the raised floor has separately lain out?

Yes, No

1.4. Can all ACs (Air conditioners) at both sites be operated at **full load** at the same time?

Yes, No

1.5. The degree of availability of suppliers that provide professional support and spare parts for ACs

High Low Medium

1.6. Frequency of failure on storage hard disks at Kera site?

Very High Medium
High Low

If there is failure, please specify the reason-----

1.7. The degree of failure on ACs of Addis Ababa site?

Very High	<input type="text"/>	Medium	<input type="text"/>
High	<input type="text"/>	Low	<input type="text"/>

Specify the reason-----

1.8. The frequency of failure for ACs at both sites?

Frequently	<input type="text"/>	not operational	<input type="text"/>
Rarely	<input type="text"/>	neutral	<input type="text"/>

1.9. As the number of equipment in the data center, the degree of increase in the power consumption for power and cooling system

High	<input type="text"/>
Medium	<input type="text"/>
Low	<input type="text"/>
Proportionate	<input type="text"/>

1.10. Referring to question 1.9, the increase in power requirement needs space and additional utility power from EEPSCO. The period within which to get service or line from EEPSCO is

Short (<3 months)	<input type="text"/>	Long (>6 months)	<input type="text"/>
Medium (6 months)	<input type="text"/>		

1.11. How would you rate the quality of SLA providers of the Cooling System?

- A) EXCELLENT
- B) GOOD
- C) FAIR
- D) POOR

2. Questions of the challenges related to internal design factors that affect the implementation of data center

2.1. In case of main data center failure, disaster recovery site can take over all the branches of CBE within

- a) Real-time

- b) One hour
 - c) Cannot handle all the branches
 - d) More than one hour
- .2.2. Redundancy of all the software or equipment is mirrored or have the same performance at both sites
- a) Agree
 - b) Disagree
 - c) Strongly disagree
 - d) Strongly Agree
- .2.3. Virtualization saves power and cooling system cost or expense
- a) Agree
 - b) Disagree
 - c) Strongly disagree
 - d) Strongly Agree
- .2.4. Virtualization requires high skill and advanced technology
- a) Agree
 - b) Disagree
 - c) Strongly disagree
 - d) Strongly Agree
- .2.5. Branches at Juba and Djibouti can access T24 application from data center in Addis Ababa
- a) Agree
 - b) Disagree
 - c) Strongly disagree
 - d) Strongly Agree
- .2.6. Cost of ethiotelecom bandwidth provided for data center is
- 1) Fair
 - 2) Low
 - 3) High
 - 4) Very high
- .2.7. Ethio telecom can provide fast services like fiber and dark fiber without any difficulties within the schedule of the project.

- a) Agree
- b) Disagree
- c) Strongly disagree
- d) Strongly Agree

.2.8. CBE can choose DC site anywhere in the country?

- a) Agree
- b) Disagree
- c) Strongly disagree
- d) Strongly Agree

.2.9. DR site of the CBE data center is selected without influence of top management and ethiotelecom service availability?

- a) Agree
- b) Disagree
- c) Strongly disagree
- d) Strongly Agree

.2.10. Unavailability of alternative or different private /government Telecommunication is a challenge to construct the data center project?

- a) Agree
- b) Disagree
- c) Strongly disagree
- d) Strongly Agree

3. Questions on constraints that limit the project team’s preference in deciding space planning and site selection

3.1. Are there any Environmental factors that affect project implementation?

Yes No

3.2. If your answer for question 2.1 is ‘yes’, what is the degree of influence to the data center?

- ❖ Very high
- ❖ High
- ❖ Medium
- ❖ Low

3.3. Does the site location for data center project professionally selected and designed?

❖ Yes

❖ No

3.4. If your answer in question 3.3 is 'YES', who decided the site location?

Contractor other please specify-----

CBE project team

CBE top management

3.5. Considering flooding, Rodents, fire and security safety, how can you explain the degree of safety?

Very safe

Safe

Medium

Low

Other specify_____

3.6. If your answer for question 3.5 is Low, how does it affect the company's performance or the degree of impact on business continuity?

Very High

High

Medium

Low

3.7. Is future expansion of site selection considered for both data centers?

Yes

No

Other please specify-----

3.8. If your answer for question number 3.7 is 'Yes', does it meet international standards related to raised floor, cabling space sufficiency and space for additional cooling and power system?

Above requirement

Meets project requirement

Below requirement

Other please specify_____

3.9. If your answer for question number 3.8 is below requirement, what is reason?

- ❖ Site selection was decided by management
- The floor selected is not enough to accommodate
- Data center facility expansion
- ❖ Not properly designed
- Other please specify _____

3.10. Is physical environment and security camera well integrated in both sites of data center?

Yes No

3.11. In principle, Disaster recovery and main data center should be located in separate place.

Where are these sites located in?

- 1) Different cities
- 2) Different place but the same city
- 3) The same place
- 4) Different country
- 5) Other specify _____

3.12. Referring to Q.3.11, Who did choose these locations?

- CBE management
- Project staff
- Contractor
- Others please specify _____

3.13 The distance between disaster recovery site and main data center is determined based on best practices

- a) Agree
- b) Disagree
- c) Strongly disagree
- d) Strongly Agree

3.14 Referring Q) 2.13, the world best practices distance between DR and DC is

- A) 7km B) 100-150km C) 1000km

3.15. Distance between two sites (AA&Kera) of data centres is

- A) 50km B) below 10km C) 100km

4. Questionnaire designed about challenges associated with service provider and SLA Contract

4.1. How would you rate the availability of certified or professionally competent Companies that provide SLA service in Ethiopia?

Very high	<input type="text"/>
High	<input type="text"/>
Medium	<input type="text"/>
Low	<input type="text"/>
Very low	<input type="text"/>

4.2. How would you rate the quality of SLA providers of the Cooling System?

- A) EXCELLENT
- B) GOOD
- C) FAIR
- D) POOR

4.3. The degree of availability of dark fiber service provided by ethiotelecom?

Very high	<input type="text"/>
High	<input type="text"/>
Medium	<input type="text"/>
Low	<input type="text"/>
Very low	<input type="text"/>

4.4. Ethio telecom can provide high performance bandwidth services like fiber or dark fiber Technology flexibly?

- a) Agree
- b) Disagree
- c) Strongly disagree
- d) Strongly Agree

- 4.5. The fiber ring service can be obtained at any place of Ethiopian territory?
- Agree
 - Disagree
 - Strongly disagree
 - Strongly Agree
- 4.6. It cannot be said the bandwidth service and disaster recovery are redundant since there is no alternative or another telecom service in a country?
- Agree
 - Disagree
 - Strongly disagree
 - Strongly Agree
- 4.7. EEPCO can provide redundant utility power source any time it is requested?
- Agree
 - Disagree
 - Strongly disagree
 - Strongly Agree
- 4.8. It is difficult to get redundant utility power from two separate substations?
- Agree
 - Disagree
 - Strongly disagree
 - Strongly Agree
- 4.9. The cost of providing power source from two different substations
- Less expensive
 - Expensive
 - More expensive
 - Most expensive
- 4.10. The dark fiber service and power redundancy service requests from respective service providers are negotiated at
- project team level
 - Director level
 - Board of director level
 - Functional manager level
- 4.11. spare parts for cooling system and other DC facility can be obtained easily
- Agree
 - Disagree

c) Strongly disagree

d) Strongly Agree

4.12. CBE Data center can obtain the bandwidth service from service provider other than Ethio telecom

a) Agree

b) Disagree

c) Strongly disagree

d) Strongly Agree

4.13. Companies which signed SLA agreement for data center cooling and power facility project are strong and internationally competent

a) Agree

b) Disagree

c) Strongly disagree

d) Strongly Agree

Part.II Opinion or perceptions about the challenges of the data center project

Please select the opinions that directly represent your opinion on challenges of data center projects and rate scales

1=Strongly Disagree (SD) 2=Disagree (D) 3=neither Agree nor Disagree (And)

4=Agree (A)

5=Strongly Agree (SA)

No.	Questions	Rating				
		1	2	3	4	5
1.	The site selection of data center is chosen and designed based on CBE requirements of the project					
2.	The data center project has faced challenges during its project activities and after implementation					
3.	The disaster recovery can take over main data center in real time in case of failure					
4.	It is safe that both sites of data center are at ground floor					
5.	The CBE project's standards of cable labeling & layout space, raise floor, location of design, space for expansion in the future meets International					

No.	Questions	Rating				
	standards of data center at both sites.					
6.	EEPCO provides redundant utility from different substations within specified schedule					
7.	Ethiotelecom has capacity to provide any requested size of bandwidth within a project schedule					
8.	CBE project depends on EEPCO and ethiotelecom for service provision					
9.	Ethiotelecom is flexible to provide dark fiber and high fiber widths anywhere in Ethiopia					
10.	The management decided the location of project site					
11.	The 3 rd party or consultant is awarded the data center bid through competition or through legal process of selecting best bidder					
12.	The power utility can support all ACs at the same time and utility power is supplied from two different substations					
13.	The cooling system faces challenges of performance					
14.	Management bias on cost minimization is one of bottleneck to choose best standards					
15.	Data center migration both physical and data movement can be done with high professional skill and competence					
16.	The CBE project staff is qualified to do the project without participation of the contractor/bidder					
17.	The 3 rd party or INSA has capability to do the project without participation of contractor					
18.	The rodent system, fire protection and security system meet the requirements of CBE and international standard					

No.	Questions	Rating				
19.	Both sites of data center are chosen at location no or minimum risk will occur if there is flooding					
20.	The redundancy of space on sub distribution board, space cabling through raised floor, cooling capacity is well considered for future expansion					
21.	Project manager is free of management influence to decide about the project site location					
22.	CBE data center network designed to provide service for oversea branches like Juba,Dijubuti and there is no need of satellite or VSAT network					

Part-IV Instructions: Please carefully read each of the following statements and respond by ticking the response box that best reflects your opinion. Please be completely open and honest in your responses.

Be sure to include a "Comments" area. You might want to include rating scale answer choices such as:

Very *somewhat* *somewhat*
very

Dissatisfied *dissatisfied* *Neutral*
satisfied *satisfied*

- | | | | | | |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 1) Working in the live environment during Data Centre upgrading project has no critical Impact on overall system. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 2) During project implementation, for every live action, it requires change advisory board (CAB) approval. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 3) The unavailability of domestic/local Companies who can Provide Professional support and spare parts is a bottleneck in data center Project success and implementation. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 4) Delay of goods and service due to poor logistic system and unavailability of local suppliers is challenging and creates behind the schedule for success of project within project schedule. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 5) Too minimum down time is allowed to implement New projects by top management and creates behind schedule then associated project parameters like cost and time trade-off occurs. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Addis Ababa University
School of Commerce Graduate Studies Program
Department of Project Management
Interview Guideline

I am a post graduate student at Addis Ababa University School of Commerce at the department of Project Management. I am currently doing a research about the challenges of IT data center Project implementation. The objective of this interview is to collect data regarding the challenges the Data center of Commercial Bank of Ethiopia face and to identify the most important challenges. You are here by kindly requested to answer the questions listed below sincerely. The data collected from the interview and the result of the survey will be used strictly for an academic purpose and will be kept confidential. Thank you in advance for taking your time to answer the questions.

Girmaw Zeleke

Job Position in the DC project

Part One: What are challenges related to Top management and Logistic?

Part two; what are the general challenges of DC project and challenges specific to the following issues?

- Power and cooling system
- Internal design factors
- Constraints that determine project team decision in space and site selection
- Challenges related availability, reliability and quality of service providers and SLA