



**ST. MARY'S UNIVERSITY SCHOOL OF
GRADUATE STUDENTS**

**FACTORS INFLUENCING STRATEGIC MANAGEMENT
DECISIONS OF ICT DATA CENTER IN ETHIOPIA: THE
CASE OF ETHIO TELECOM.**

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JANUARY 2017

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DECLARATION

I, the undersigned, declare that this thesis is my original work, prepared under the guidance of Tesfaye Debela (PhD). All sources of the materials used for this thesis have been duly acknowledged. I further confirmed that the thesis has not been submitted either in part or in full to any other higher learning institution for the purpose of any degree.

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JANUARY 2017

ENDORSEMENT

This thesis has been submitted to St. Mary's University, School of Graduate Studies for examination with my approval as a university advisor.

Advisor

Signature

St. Mary's University, Addis Ababa

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ABBREVIATIONS

BoD	Board of Directory
EIU	Economist Intelligence Unit's
CO2	Carbon dioxide
DC	Data Center
DCIM	Data center Infrastructure Management
DNS	Domain Name System
ET	Ethio telecom
e-waste	Electronic Waste
FDRE	Federal Democratic Republic of Ethiopia
FTP	File Transfer Protocol
GDP	Growth Development Program
GHG-emission	Greenhouse Gas emission
HR	Human Resource
IBM	International Business Machines
ICT	Information Communication Technology
IP	Internet Protocol
IS	Information System
IT	Information Technology
ITIL	IT Infrastructure Library
ITSM	IT Service Management
NGN	New Generation Network
NTP	Network Time Protocol
PAAS	plat form as a service
PUE	Power usage efficiency
SAAS	Software as a service
SAN	Storage-Area Network
SLA	Service Level Agreements
TCO	Total Cost of Operating
TEP	Telecom Expansion Program
TIA	The Telecommunications Industry Association
TIA-942	TIA-942 is a standard developed TIA
TQM	Total Quality Management
UN	United Nations
UNEP	United Nations Environment Programme

ABSTRACT

Information and Communications Technology is an increasing factor in the everyday life, whether this is private or public. In coherence with this, reports and research presents the contribution to effects in terms of pollution, such as greenhouse gas emissions and electronic waste. The research in the area of information communication technology (ICT) data centers, that consume about 2% of energy that is produced worldwide mainly focuses on technological solutions. In this study, the researcher aimed to identify the challenges and opportunities (trends, pressures and factors) that affect ICT data center management decisions which has not been studied extensively. To answer the research questions the researcher carrying out a literature review and he used the initial decision-making research model as a guide for the process of gathering primary data. He prepared semi-structured interview questions to gather the primary data via interviews with expertise in the ICT data center of Ethio telecom.

The main trends for ICT data center management decisions that identified from the primary data by the interviewees were virtualization and cloud computing. Furthermore, the main pressures in regard to strategic operations decisions of ICT data center were mimetic, coercive and normative pressures which includes service availability, costs, government and customer pressures. In addition to that the main factors that are identified after gathering the primary data from Ethio telecom includes service availability, cooling, costs, reliability, technology, organizational management, security, customers, speed, virtualization, facilities, energy consumption, data center management, location, human resources, quality management, storage, and service level agreements. It was found that environmental sustainability is to a large amount seen as a bi-product of the aim for general efficiency in ICT data centers among the interviewees from Ethio-telecom. In terms of factors related to environmental sustainability costs, energy consumption, cooling and e-waste were identified being paid the most attention to by the interviewees.

Keywords: ICT data center, data center management, environmental sustainability, strategic operations decisions.

CHAPTER 1: INTRODUCTION

Chapter 1 presents the research outline of the study. It begins by introducing the background of the study and highlighting the problem statement of the study. It is then followed by the research questions, research objectives and research scope/delimitation. Finally, the chapter ends with the significance and Organization of the study.

1.1 Background

The growing industry of Information and Communication Technology requires higher computing capacity of data centers. Current reports indicate that the agendas of enterprises, governments and societies increasingly include how to tackle environmental problems and how to adopt new environmental practices. This trend is leading to a global dialogue about natural capital and the greening of economies (Murugesan, 2008). Furthermore, the dialogue is fostered by the awareness and increasing demand for actions to deal with climate change that became prominent in the first half of the 21st century. Although this increase in awareness contributes to the effort that is undertaken to ensure environmental sustainability, the overall global progress to achieve this goal is slow (United Nations Environment Programme, 2011). Since the seventies, the term “sustainable” has gained popularity in academia as well as in the non-academic world (Davison, 2008). Moreover, it found its way of being widely used for defining ‘Sustainable Development’ as of the World Commission on Environment and Development (World Commission on Environment and Development, 1987, p. 51) that published the following definition: “Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future.”

In the last decades, the rapid development and availability of Information and Communication Technology (ICT) has contributed to an improved lifestyle of modern society regarding the everyday life (United Nations Environment Programme, 2011; Murugesan, 2008). As of 2007 the ICT Sector inherits 7.3% of global GDP and is predicted to reach the value of 8.7% by 2020 (The Climate Group, 2008). In addition to the beneficial contribution of ICT and the rapid growth of this industry, it also came paired with negative aspects throughout its lifecycle beginning with the production of ICT products, their use and their disposal. Those negative aspects include the increasing amount of electronic waste (e-waste). Due to the short lifetimes of ICT products, an increasing amount of disposed electronic waste is present and is causing environmental contamination as checked and other in (Herat & Bahadir, 2007; Elliot & Binney, 2008; Kurp, 2008).

Moreover, the energy used by ICTs is generated using mainly fossil fuels which present another way of its contribution to an increase in CO₂ emissions and thus the greenhouse gas effect. The trend that started to develop in the ICT industry, creating and introducing “Green” products, addresses this issue. The goal is to decrease the amount of the contribution of ICTs to these emissions (Katzner, 2007; Kurp, 2008; The Climate Group, 2008).

The energy needed during the manufacturing process of a personal computer is four times bigger than the total annual amount of electricity that is consumed by the personal computer throughout its whole life cycle. Moreover, the amount of energy a computer consumes exceeds the energy a refrigerator needs per year (Williams, et al., 2008). Furthermore, the users’ high demand of Internet and Web applications is also leading to the rapid increase of the amount of data centers that are needed by the enterprises to provide these services. This is achieved by extending existing data centers up to their limit in special capacity, or by establishing new ones, also in areas that have not been serviced by data centers before. In the rapid process of this expansion in the last decades this resulted in a six-fold increase of the number of installed server computers in the world (Murugesan, 2008).

1.2 Statement of the Problem

As pointed out in the background section of this thesis it can be seen that ICT, besides the given positive impacts, such as optimization, efficiency, connectivity and so forth, also has a negative impact in terms of generating environmental problems along the life cycle. Data centers (DCs), which are a specific and wide spread type of ICT, consume significant amounts of electricity. Reports state, using the examples of Apple and Google, that Apple’s data center continuous consumption is equal to the energy consumption of 250,000 households while Google’s equals 200,000 households (Cook & Van Horn, 2011; Glanz, 2011). This creates bigger demands for electricity production, the estimated growth for 2012 is 19%, thus increasing CO₂ emissions and contributing to faster pace of global warming (Datacenter Dynamics, 2011; Vykoukal, et al., 2009). In 2010 data centers were estimated to consume 1.3% of globally produced electricity, accounting for \$7.2 billion electricity costs (Koomey, 2007; Koomey, 2011). The increasing prices of energy worldwide result in higher operational expenses of data centers, which is equal to 20% of the total cost of ownership of a data center (APC, 2005; Murugesan, 2008).

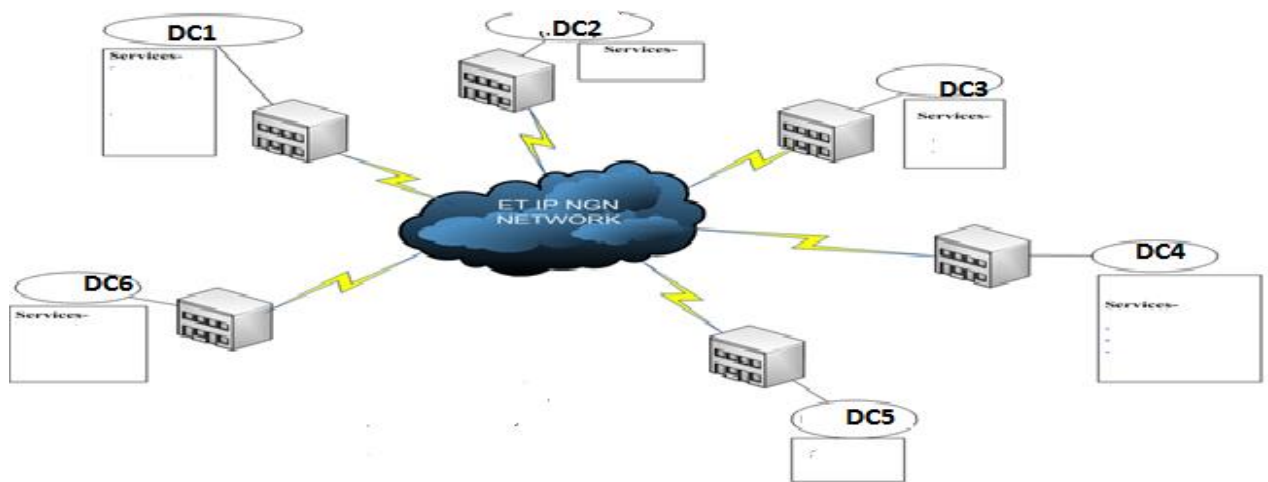
Although, these facts suggest data center management to be highly relevant, constraints such as financial, practical and social might hinder the reduction of data center energy consumption in

businesses and their IT departments. IBM's and Economist Intelligence Unit's (EIU) research claims that only 45% of the organizations have a program to deal with "greening" issues and, among those, less than half (48%) of them have specific program targets (The Economist Intelligence Unit, 2007; Murugesan, 2008).

Ethio-telecom is a government owned monopoly telecommunication service provider in Ethiopia. From time to time the demand of telecommunication service is growing rapidly in Ethiopia, based on the high demand of the telecom service the government has been given an attention for the expansion telecom sector as one subprogram of the National Growth & Transformation Program (GTP-I/II). The infrastructure of Ethio telecom is growing after the implementation of two consecutive mega projects (New Generation Network (NGN) project which costs 1.5-billion-dollar investment and Telecom Expansion Project (TEP) project which costs 1.6-billion-dollar investment). The two pervious mega projects of Ethio-telecom did not consider the Green data center strategy for environmental sustainability in Ethiopia.

Ethio telecom has non-standard, small scales and scatted data centers in Addis Ababa and regions of the country. All the existing data centers are traditional data centers which did not follow the Green strategy. Some of the existing challenges observed in Ethio telecom data centers are poor Power Usage efficiency (PUE) design and utilizations, poor cooling system design and utilizations, lack of standard facility materials, poor location selection, operational and maintenance challenges, lack of consideration the environmental sustainability and social factors. Those gaps are observed in Ethio telecom data center management decision.

Figure 1.1 Current Ethio telecom ICT data center sites



Source: Selected and compiled by the researcher from the interviewees

- The above systems are major systems in the existing Ethio telecom data centers, but there are also many managed systems in other equipment rooms.
- These are just equipment rooms or scattered data centers in the existing old buildings and cannot meet data center standards.
- Nowadays, Ethio telecom demands strategic shift to own standard and state of the art data centers to become world class telecom operator & in order to sustainable in the competitive world.

1.3 General and specific research questions

Having introduced the problem strategic management decisions of ICT data centers the researcher conclude the problem statement with the following general and specific research questions. The research focuses to highlight the key decisions that data center users and owners are facing and the questions address different stakeholder perspectives.

The general question: What trends, pressures and factors affect Strategic management decisions of ICT data center in Ethiopia: The case of Ethio telecom.

The specific research questions are:

- What trends, pressures and factors affect strategic ICT data center management decisions?
- Is there any prioritization within the factors that affect the ICT data center?
- Do these factors affect each other and if then how?
- What is the role of sustainability in data center management decisions?

This research explores the trends, pressures and factors that are considered in a data center management operation. Furthermore, the researcher want to explore the extent of the consideration of environmental aspects in strategic data center management decisions. Moreover, the researcher want to find out if there is a priority between the factors and also if these factors affect each other and how.

1.4. General and Specific Research Objectives

The general objective: To identify the trends, pressures and factors that affecting the strategic management decisions of ICT data center in Ethiopia: The case of Ethio telecom.

The specific objectives are:

- To identify the trends, pressures, and factors affect the management of ICT data center during operation in the telecom sector,
- To identify the prioritization of the factors and how to affect each other
- To identify whether the factors are affect each other and to answer the how question
- To examined the role of ICT data center management decision in the environmental Sustainability.

This is seen relevant as one can find a lot of articles and general talk about the topic of sustainability in this field, but not so much about what is really done and what is thought by managers and decision makers in the industry. The factors identified during this research were prioritized and the connection between the factors were examined. The aim of this study was to contribute through creating a research model, based on theory in service operations management and incorporation of sustainable aspects of ICT data center technologies. This model is tested by carrying out interviews with different data center professionals in Ethio telecom. After testing the model, it was altering and then presented in a final model. In addition, the contribution to the existing literature this research could then been used to further drive the development of a model relevant for data center professionals throughout the different stages of the life cycle of such an operation. It has been seen as one step that could be taken in to further studies. Moreover, it could help organizations as a point of venture to deploy their data centers in a way that aims to drive both, economic and environmental sustainability.

1.5. Definition of keyword terms

The area of data center management is a highly multidisciplinary field bringing together different aspects of management such as ICT management, Business Continuity Management, Facility Management and so forth. Moreover, aspects of engineering such as for example Electric Engineering, Environmental Engineering have to be considered as well. The aim of this section is to provide definitions of the main objects that are dealt with in this study regarding Trends, Pressures and Factors that affect data center management with a focus on sustainability.

Table 1.1– Keyword search terms

Category	Search terms
Data Center centered search terms aiming to identify literature directly related to the research carried out in this study	data center management’, ‘data center infrastructure management’, data center operations management’, data center management factors’, ‘sustainable data center management’, ‘sustainable data center operation’, ‘data center management trends’, ‘data center management pressures’, ‘data center management challenges’
Sustainability, ‘green’ and ICT centered search terms	‘sustainable data center’, ‘green data center operations’, ‘sustainable ict infrastructure’, ‘green ict management’, ‘sustainable it infrastructure’ ‘trends and pressures for sustainable ict’, ‘green ict operations’,
Management and ICT centered search terms	‘operational management’, ‘operations management factors’, ‘ict operations management’, ‘ict service operations’, ‘management and green ict’, ict management’, ‘ict service management’, ‘service operations management’

1.6 Significant of the Study

Some of the research study stated that rising global energy prices causes a significant increase in data center operational budgets. Most large enterprise IT organizations expect the energy component of their IT budgets to rise by 2 to 3 times within 5 years, putting pressures on IT growth and forcing Organizations to further prioritize IT investments (IBM Corporation, 2010). Requirements for new data center floor space is growing aggressively and had prompted organizations to deploy latest high density server systems. High density systems require considerably more power and cooling than the last generation of hardware. Lack of sufficient cooling had caused significant equipment downtime 30% of carbon emission comes from the power industries. More organizations are adopting higher corporate social responsibilities; environmentally positive attitude will force changes in the way IT is

used. Traditional data centers were not built to be environmentally friendly – over 60% of the cooling energy is wasted, (IBM Corporation, 2010).

The findings of the study are significant as it is expected to enhance the awareness of stakeholders with regard to solving the challenges of the factors, trends, and pressure that affect management of ICT data center for environmental sustainability in Ethiopia, case in Ethio telecom to move towards the Green data center management. In this regard, the study could lift up the national image in the IT industry with value added by using the Green IT services and a great importance in filling the knowledge gap that exist among stakeholders (includes all public and private IT & ICT service users, and ICT service providers, like telecom sectors Ethio telecom, bank sectors, educational institutes like universities, IT service providers, other organizations, individuals and society are stakeholders that impacted positively or negatively). Furthermore, the outcome of the study serve as one stepping stone to initiate and expected to assist other researchers for further studies in the area of green IT data center management to take environmental sustainability into account in Ethiopia.

From the practical point of view, this study is important in understanding the key factors that affect the management of ICT data center. Nowadays, IT data center plays an important role in environmental sustainability. Many businesses in developed country are aware of green IT data center management issue and started to implement in their strategies or policies. Thus, for developing country like Ethiopia, it is important for IT firms to embrace green IT data center in order to meet global demand towards green and sustainable development. The findings from this research is therefore serve as a guideline for top management team to strategize and implement appropriate actions towards green ICT data center adoption for better performance. Besides, researchers can use this study to understand the important drivers and values which influence the green ICT data center adoption. On the other hand, the findings will offer a standard for practitioners to assess and evaluate their green IT data center adoption.

This research is the qualitative study in order to understand green IT adoption in Ethiopia: the case of Ethio telecom. The findings from this study are theoretically contribute to the existing knowledge on green IT data center while practically provided some useful recommendations for practitioners like Chief information officers (CIOs), IT managers, environmental and sustainability managers. Lastly, this study also offers new opportunities for further research in this area.

1.7. Scope & limitation of the study

The researcher does not intend to carry out an in-depth investigation about general organizational factors, as the researcher want to give the more projecting role in this research to trends, pressures and factors in relation to strategic data center management decisions that are set in relation with environmentally sustainable factors. In contrary to the prominent role of environmental sustainability the researcher does not aim to only provide a thesis written in an “environmentally friendly” style rather than exploring the perception of these issues in the “real” world. Although the researcher is incorporated technological approaches that have the ability to contribute to sustainability, he will not include a detailed technical analysis of those green ICT data center aspects, as the researcher will focus on the Trends, Factors, and Pressures that affect data centers mainly on a data center management level. The point of connections among and factors of how the factors affect each other is represented in the model. However, a detailed research into why and how much they affect each other will not be carried out due to time limitation. In this study two organization was participating during the primary data collection. The first one is Ethio-telecon which is the owner of the ICT data center under study and the second organization is the Ministry of environment, forest and climate change in Ethiopia.

1.8. Organization of the study

This study consists of five chapters. The first chapter presents an introduction part includes background of the study, statement of the research problem, objective of the study, scope and limitation of the study and definition of terms. Chapter two deals with review of the literature. The research methodology is examined in chapter three. In chapter four the findings of the analysis are presented and discussed in detail. Chapter five consists of conclusions and recommendation of the study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The aim of this section is to provide definitions of the main objects that are dealt with in this study regarding Trends, Pressures and Factors that affect management of ICT data center for environmental sustainability in Ethiopia: The case of Ethio - telecom. Due to it is being a fairly new field, not much theory exists that could be tested in a quantitative fashion. Instead, the research will examine what the current literature suggests, as well as applying theories from other fields. In this case, qualitative research methods are more appropriate. The section covers review strategy, review findings, literature frameworks like data center management, operation management, sustainability related to be examined. In addition to that, factors in strategic operation decisions with related to ICT data center (Structural factors & Infrastructural factors), factors related to environmental sustainability to be examined. And then, Pressures (Mimetic pressure, normative pressure, & coercive pressure) and Trends (virtualization, consolidation, and cloud computing) are also to be examined within the literature review. Finally, the Initial Decision Making Research Model will be presented.

In order to gain a deeper understanding of the subject of factors that affect the management of ICT data center for environmental sustainability, a literature review is undertaken. This is the foundation of the study. Based on the literature review, trends, pressures and factors affecting the management ICT data center and the sustainability related issues to be discussed. The aim of the literature review is to examine the existing material on ICT data center management, and other material that can be applicable to the subject of the study.

The material to be examined in the literature review are key words found from Google scholars, books and articles, but also includes reports from organizations and governments and other researchers result to be examined. As Green ICT Data center management is a fairly new subject, without an existing, clear foundation, finding good and reliable sources could prove difficult. One possible strategy is to use material from related fields, and to find the ways in which it can be useful in the field of management of ICT data center for environmental sustainability.

2.2 Literature Review

Green information systems (Green IS) and green information and communication technology (Green ICT), in the specific case of this research green information technology (Green IT), are topics that

receive extensive attention from scholars and researchers in the academic world. However, in all of these fields, management and technology related publications regarding data center management and thus also the literature and publications on Sustainable or green data center management is found to be almost non-existent. Extensive research is being carried out regarding the technological and electrical aspects of how to minimize electrical consumption and increase efficiency in data centers.

Green: Before delving deeper into the subject of Green ICT, Green IS, and green IT ‘green’ must be defined. Agarwal and Nath (2013) say that “green is used in everyday language to refer to environmentally sustainable activities” (p. 46). Being green is often used synonymously with being sustainable. Although these two concepts are closely linked, they are not identical. Being green is only a part of being sustainable. The United Nations often talk about the three dimensions of sustainable development, which are the social, economic and environmental dimensions (UN, 2013). Being green would correspond to the environmental dimension. However, it is clear that these dimensions are often interlinked, and that what is desirable from an environmental standpoint can benefit the other dimensions as well, like Zhang and Liang (2012) point out when they link green ICT with economic growth.

Green ICT: It is defined in the literature as “the using of IT resources in an energy-efficient and cost-effective manner” (Bose & Luo, 2011, p. 39) or “an initiative to encourage individuals, groups, and organizations engaged in the use of ICT to consider environmental problems and find solutions to them” (Chai-Arayalert & Nakata, 2011, p. 220). green ICT is concerned with the environmental impact of the ICT sector itself, whereas ICT for Green, which will be explained below, details how ICT can be used to green other sectors. 2% of the world’s GHG emissions come from the ICT sector, famously likened to the emissions from the aviation sector (Mingay & Pamlin, 2008). This may not seem much, but according to Despins et al. (2010) the ICT sector is the fastest growing sector when it comes to emissions, increasing its emissions at a rate of 6% annually.

Green IT (green information technology): ... the study and practice of designing, manufacturing, using and disposing of computer, servers and associated subsystems ... efficiently and effectively with minimal or no impact on the environment (Murugesan, 2008).

This view focuses on improving energy efficiency and equipment utilization through steps such as designing energy efficient chips, virtualization, reducing data center energy consumption, using renewable energy to power data centers, and reducing electronic waste [Watson et al., 2008, p. 2].

Green IS (green information system): Defined by Watson et al. [2008], includes the use of information systems to enhance sustainability across the economy. This view includes improving efficiency in industries that are major sources of GHG emissions (carbon dioxide emission), such as the transportation, manufacturing, and energy sectors.

The Green IT view sees IT primarily as a problem to be mitigated; for example, data centers are a rapidly growing source of carbon emissions and need to be made more energy efficient to reduce their impact on the environment. The Green IS view sees information systems as a possible solution to many environmental problems. For example, electricity generation is a major source of GHG emissions; —smart grid technology can employ information systems to increase efficiency in the production, transmission, and use of electricity. Ultimately, IT should be viewed both as part of the problem and part of the solution [Fuchs, 2008].

2.2.1 Data center management

The main object of this study is related to data center operations and relevant factors that influence the management decisions. In order to elaborate on the literature on data centers, the terms “Data center” is defined and set into a context with its overall environment. Coming from a technical background of literature published by Cisco Press with the aim to provide information about data center technologies a definition of a data center is (Arregoces & Mauricio, 2004): “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, whether IP or storage-area network (SAN). [...] Additionally, a number of servers support network operations and network-based applications. Network operation applications include Network Time Protocol (NTP); TN3270; FTP; Domain Name System (DNS), [...]” (Arregoces & Mauricio, 2004, p. 5)

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. These aspects include for example environmental controls and security: “[...] 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

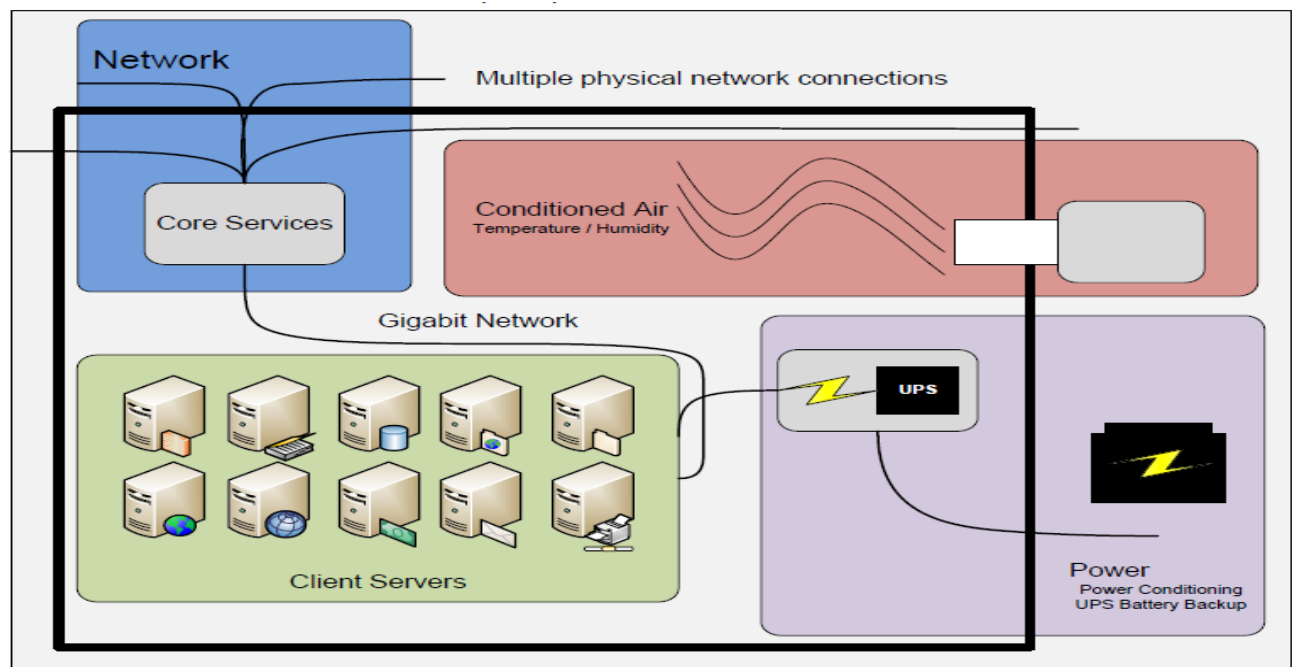
controls (e.g., air conditioning, fire suppression) and security devices. Data centers house typical computing resources in controlled environments, managed centrally to enable enterprises to operate according to business needs.” (Chandra & Prasad, 2010, p. 129).

As stated before providing the definitions, a data center’s main purpose is to support a business. Therefore, the management 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 (Mukherjee, et al., 2010).

Figure 2.1 shows a high-level abstract of a typical data center. Chandra (2010) points out that the typical components that are relevant for a data center consist of its servers, including hard- and software, and the energy that is needed to run those and the battery backup. Moreover, multiple 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 a key.

In Figure 2.1 the black rectangle presents the physical border between internal and external world. This also represents the security aspect of having the data center set up in a security perimeter to protect data stored in the facility. The total of these aspects represents the core services that can be developed and offered to internal or external clients by a data center.

Figure 2.1- Typical data center (Chandra, 2010)



Source: Typical data center (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. 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).

2.2.2 Operations management

Continuing from the previous section and having data centers defined as belonging to operational units that can offer various services to their stakeholders, the literature is then further examined to identify relevant theoretical frameworks for this study. Due to the gaps that are identified in chapter 2.2, and the lack of explicit theory that addresses data center management, the focus is then set on operational management theory and service science theory. A basic definition of operations management is: “Operations management is concerned with those activities that enable an organization to transform a range of basic inputs like materials, energy, customers’ requirements, information, skills, finance, etc. into outputs for the end customer (Brown, et al., 2005, p. 8). In regard to Information Technology (IT) many fields contribute to the field of IT Service Management (ITSM). Contributing fields include for instance “[...] computer science, operations research, industrial engineering, business strategy, management sciences, social and cognitive science, organizational theory [...]” (Galup, et al., 2009). Thus, a data center can be seen as a complex unit of operations that offers services comprising of multidisciplinary inputs. According to the literature search, using the defined search terms, there is a large amount of literature available concerning operations management.

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 (Hitachi Data Systems, 2010). 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 show, by the year 2012 the data center equipment’s power costs will be more than money spent on the original data center's investment (U.S. Department of Energy, 2008). 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). A correctly designed air management

system in combination with strategic investments on equipment could reduce the costs by increasing data center's efficiency simultaneously (Normandeau, 2011; VanGeet, 2011; Mata-Toledo & Gupta, 2011). 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; Mata-Toledo & Gupta, 2011).

As mentioned before the factors that are seen relevant in operations management literature are separated into two main categories, namely structural and infrastructural. In order to fit the factors identified in the literature review into the research model. they will be presented already assigned to their principal category below.

2.2.3 Environmental sustainability

Environmental sustainability become an essential and universal public issue today. Climate change, the depletion of natural resources, world population increase, scarcity of food and others had drawn a high attention to the people. During the past few years, political discussions are intense and widespread coverage in the media in resulted communities around the world has awakened to the environmental sustainability issue. Nowadays, climate change and the environmental problem had become people most concern and caring issue. Somehow, environmental problem is highly discussed than any other socio-political matter. This can be further proven in Bonini et al. (2008) study. Consumers' feedback that a corporation's strategic move towards handling climate change and environmental problems will affects them in their trust to the company resulted whether they would purchase its products. Bonini et al. (2008) also stated that consumers want companies to promote the public good by providing healthier and safer products.

Russo (2003), the term sustainability has "acquired so many overlapping definitions and the definitions seem to be increasing in number of words." An appropriate definition is proposed by the World Commission on Environment and Development (1987) suggested that sustainability is "development that fulfils the present needs without threaten the future generations' ability in acquiring their needs". This definition had been widely adapted in many researcher studies.

The IT industry has an important role since its contribution to the environmental issues is of major importance. This impact can be found throughout the life cycle, starting from the production process, the usage of IT products and their disposal. All of these stages contaminate the global environment by

consuming electricity and releasing greenhouse gases to the environment (Murugesan, 2008). IT therefore has to be characterized as a relevant topic with regard to sustainability, since it has contributed significantly to the environment problems our planet is facing. The contribution to the elimination or minimization of its environmental impact could be defined as essential in terms of creating a more sustainable IT that preserves the environment for the next generations (Murugesan, 2008). As a consequence of this situation that has drawn concerns upon in the world, the IT operations decisions should be taking sustainability into account not only because of increasing regulations imposed by governments force this, but also pressures from other stakeholders are increasing. Therefore, organizations have to start facing the issue and take sustainable actions (Kuo & Dick, 2009). As defined by Starik and Rands. (1995, p.909) ecological sustainability is: “[...] the ability of one or more entities, either individually or collectively, to exist and flourish (either unchanged or in evolved forms) for lengthy time-frames, in such a manner that the existence and flourishing of other collectivities of entities is permitted at related levels and in related systems. According to the literature there are three basic ecological goals of sustainability and these are the following: eco-efficiency, eco-equity and Eco effectiveness (Watson , et al., 2010). These will be explained in the following section.

Eco-efficiency: Organizations use eco-efficiency as defining expression to easily sum up the concept of sustainable development in only one word (Dyllick & Hockerts , 2002). As stated by the World Business Council for Sustainable Development (1997, p. 9) “Eco-efficiency is achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with the earth s estimated carrying capacity.”

Eco-equity: As stated by Gray and Bebbington (2000 p.3) eco-equity refers to the: “[...] equity between peoples and generations and, in particular, the equal rights of all peoples to environmental 'resources'.” Eco-equity is essential to be considered as a part of an organization’s value systems in order to increase the environmentally friendly strategies that are being implemented by them. (Chen, et al., 2008) The main focus of eco-equity is the current generation’s social responsibility towards future generations.”

Eco-effectiveness: McDonough and Braungart (2002, p.76) stated the concept of eco-effectiveness as follows: “Our concept of eco-effectiveness means working on the right things—on the right products and services and systems-instead of making the wrong things less bad [...]”. The concept of eco-effectiveness means that governments and organizations should try to take the ‘right’ decisions in regards to sustainability. (Watson, et al., 2010), Chen et. al. (2008) mention in their article that

effectiveness is about how people should strive to make the best choices and do the right things, rather than only using the resources in the most efficient way.

Organizations emphasize on sustainability seem to be an extra investment, like adopting new technologies and practices that are more efficient and effective which involve a larger amount of money. But Watson et al. (2010) goes on to propose that “seeking sustainability does not mean abandoning economic thinking”. Just like Molla (2009) argued that business seeking for environmental sustainability is just one of the three pillars of sustainability. The other two are economy and community. Modernization and industrialization lead to increase in number of IT and its related equipment. Larger data centers consume much power. Thus, with a focus on IT, Watson et al. (2010) states that “IT investments are growing, and sustainability requires a reduction in computer related energy consumption”. This can be seen as a direct link to green IT.

2.2.4 Factors in strategic operation decision frameworks

Strategic operation decision factor Frameworks are created by (Angell & Klassen (1999), Roth & Menor (2003), Wheelwright & Hayes (1985), Combined with Literature review to study the factors that affects management decisions of ICT data centers for environmental sustainability. Since, Management of ICT data center is one of the operational factors in Strategic Operation Decisions which impacts the environmental sustainability. Strategic Operations Decisions are made taking several factors into consideration (Roth & Menor, 2003). In order to continue the research, first it is better to definition of what does regard as being a factor in this research. A factor is a parameter that is considered being important in regard to strategic operations decisions in data center management. This includes structural, infrastructural and environmentally sustainable factors. In the next sections the researcher will present the identified factors found in the literature review of this research.

2.2.4.1 Structural factors

Structural factors related with ICT data centers to become Greener consists of facilities of data centers, capacity of the data center, vertical integration and technology used in data center are presented below.

Facilities: The physical compound, an operation is set up in, has a high impact on how well this operation is performing. Therefore, the design and planning of the facility is a crucial point when establishing a new operation. This includes decisions ranging from the location of the facility itself to the layout of the floor. In terms of a data center this is important because of several aspects that have

an impact on the overall operation. This includes aspects of location, connectivity and redundancy in terms of energy and network, cooling, security, and floor layout (Brown, et al., 2001).

Capacity: 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).

Vertical integration: Vertical Integration is a key factor throughout the operations management literature. The operation is part of an organization, and in order to achieve the most beneficial outcomes for the organization has to be well integrated into the value chain. In terms of IT, and especially a data center operation this is crucial. If the parts of the organization are not well integrated, the overall organization will fail to deliver services at the right quality, within in their set costs, or at the right time (Brown, et al., 2001)

Technology: Operations management is closely intertwined with the technology that is used in the process in order to produce the product or service an organization wants to sell. At the beginning of the research in this field a focus is set on manufacturing. Technology is always seen as a part to drive production and increase profitability. Service operations management theory also takes technology into consideration. In a data center this is a very important factor, as the goal of the whole operation is solely to provide services purely based on technology (Fitzsimmons & Fitzsimmons, 2006)

2.2.4.2 Infrastructural factors

Infrastructural factors that should be considered in the strategic operation decisions of ICT data center management for environmental sustainability consists human resource, quality management, planning & control, process and service are presented in this section.

Human resources: In the competitive environments that are found in current economical environments and the requirements of service oriented markets the people and their capabilities are main differentiators. In terms of Operations Management this is relevant to help recruiting the people that are capable to manage complex organizations in the mentioned competitive environment. Regarding service operations, the general focus in terms of Human Resources is the transformation of information, people into intellectual property. (Brown, et al., 2001)

Quality management: Several approaches have been studied in the area of quality management. This has led up to the widely-known approach of Total Quality Management (TQM) (Fitzsimmons & Fitzsimmons, 2006). In terms of a service operation, such as a data center, the quality is determined by several aspects, such as availability of a service, accessibility of a service, time to recover, and so on (Chandra & Prasad, 2010). These measures are defined in an agreement that is signed between customers and service provider. These agreements are called Service Level Agreements (SLAs).

Planning & control: Planning and Control is a key factor in operations management. The relation between planning the operations activities and monitoring/measuring the outcome is a key to establish a well operating unit that can deliver the required services in time, within budget and in the desired quality. Planning & Control therefore needs inputs from other key factors in the operations management and makes use of processes and management frameworks (Brown, et al., 2001; Adam & Swamidass, 1989)

Processes: In order to integrate the operation into the overall organization, well defined processes are necessary. The research in the area of operations management has therefore been extensive. In terms of data center operations, the industry is ahead of academia by providing tailored service operations framework that solely aim at delivering IT services. A major framework that is used to do so is called IT Infrastructure Library (ITIL), which is actual perceived as a standard in IT service management. In order the process management to be improved within the data center is important a specific process to be created which will provide the opportunity to the personnel involved to make the decisions together. Moreover, the data center manager should set tangible goals and create a tool for making decisions based on the cost analysis (Greenberg, et al., 2006). Finally, the improvement of the application monitoring and facilities' performance tracking is essential for the improvement of process management (Greenberg, et al., 2006; Ebbers, et al., 2011).

Services: As mentioned previously a data center is a type of a service operation unit (Fitzsimmons & Fitzsimmons, 2006). Whether this is the core business of the overall organization or just a part of it in order to carry out supporting functions, the purpose is to deliver a set of IT Services. These services include e.g. data storage, providing collaborative working environments, providing processing power, and so forth. These services are developed as the products that are delivered to customers and their characteristics are defined within the SLAs that are signed between the organization and their customers (Chandra & Prasad, 2010).

2.2.4.3 Factors related to Environmental Sustainability framework

The following sections present the factors that are seen related to environmental sustainability in data center operations which consists of energy efficiency, cooling techniques, Green IT, and E-Waste (reduce, reuse and recycle).

Energy Consumption: Over the last years, 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).

Cooling Techniques: 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). 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; Kant, 2009) 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). 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).

Green IT: Consolidation, centralization and virtualization according to studies can be considered as a key topic of interest for data centers Managers (Normandeau, 2011). It is typical in a data center many machines to remain in idle situation or even to be underused which results in useless energy consumption. A green initiative that could be followed is consolidation which provides the opportunity to the system to use fewer servers and more actively by installing more programs on fewer machines and by deactivating the ones which are not needed which can contribute to the reduction of energy consumption as well (Ebbbers, et al., 2011; Cappuccio, 2010; Garbin & Change, 2009) Consolidation is an activity which results to the diminution of the management complexity as well as to the enhancement of security and control of the system (Hitachi Data Systems, 2010; U.S. Department of Energy, 2008). Consolidation is considered as the systems' main component to move to a smarter and more efficient data center since it manages to reduce the energy consumption by

reducing the heat load simultaneously (Ebbbers, et al., 2011). On the other hand, virtualization can reduce the energy consumption by simplifying the IT environment since it provides the opportunity to run more than one operating systems on a server or a personal computer (Ebbbers, et al., 2011; Garbin & Change, 2009).

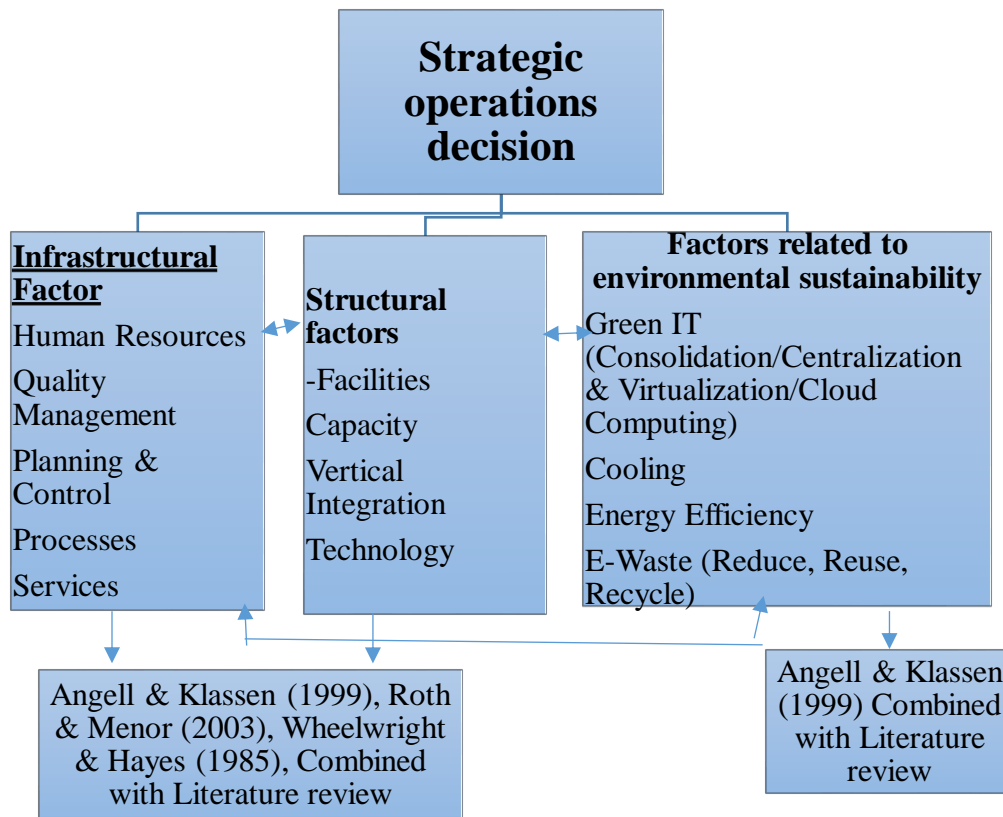
Another green technology that gained popularity in recent years is cloud computing. The use of cloud computing technology has been increased by 15% and as studies show it is considered as a key topic of interest, out of a variety of services offered by the web, for the data center managers (Normandeau, 2011; Kant, 2009).

E-Waste (reduce, reuse and recycle): Electronic-waste (e-waste) might be considered as a global issue. Since the unnecessary IT equipment usually ends up contaminating landfills, data centers have to deal with the problem of e-waste produced by their own organization (Murugesan, 2008; Chen, et al., 2008; Kuo & Dick, 2009). E-waste is defined by Swedish Environmental Protection Agency (Naturvårdsverket) (2011, p.17) as: “[...] a generic term comprising all electrical and electronic equipment (EEE) that have been disposed of by their original users, and includes everything from large household appliances, such as refrigerators, microwave ovens, television sets, and computers, to hand-held digital apparatuses, cell phones and toys”

According to studies analysts predict that almost 580 million computers out of 870 that will be produced the next five years will be disposed in landfills (Murugesan, 2008). The toxic materials included in computers’ components such as cadmium and chromium have a severe environmental impact while e-waste is not disposed in environmental friendly ways (Murugesan, 2008; Kahhat, et al., 2008; Widmer, et al., 2005). It is essential for data centers to adopt new policies and systems in order to reduce, recycle and reuse their e-waste (Kahhat, et al., 2008). Another way to reduce the e-waste is to decrease consumption and frequent replacement of IT equipment in data centers (Murugesan, 2008).

Figure 2.2 Shows strategic operation decision factors framework (Angell & Klassen (1999), Roth & Menor (2003), Wheelwright & Hayes (1985),

Figure 3.2 Strategic operations decisions factors selected and compiled by the researcher



Furthermore, the factors identified in the publications including their overall occurrence across the selected literatures. The structural, infrastructural and environmental factors that have been analyzed in the second chapter are combined and to be presented in a final table

Table 2.1-Combination of factors related to data center operations

	Category	Detail factors or variables of data center operations
Strategic Operation Decision Factors	Infrastructural	Human Resources Quality Management Planning & Control Processes Services
	Structural	Facilities Capacity Vertical Integration Technology
	Environmental Sustainability	Green IT Consolidation, Centralization and Virtualization <ul style="list-style-type: none"> . Multiple operating systems are set upon one computer or server. . Minimize idle servers-use less more actively . Simplify IT environment . Mitigate applications into fewer images . Reduce Operational Costs . Remove physical resource boundaries . Increase hardware utilization Cloud Computing Highly virtualize Catalog web services Pool resources Employ subscription and usage based billing model
		Energy Efficiency PUE Adjust Thermostat Minimize power distribution losses Reduce standby loss Rightsizing, floor layout Manage and enhance performance
		Cooling Techniques Free cooling equipment Overcooling Costs Airflow distribution Temperature control Optimize air handling Economizer to cool Data center E-waste (Reduce, Reuse, Recycle)

Source: Selected and compiled from the literature review by the researcher

2.2.5 Pressures related framework created by DiMaggio and Powell (2003)

As DiMaggio and Powell (1983) identified institutional isomorphism exists in three basic

different types which could be mimetic, normative or coercive. Each one of them will be examined in the following section.

Mimetic Pressures: A major factor that can force an organization to copy strategies being implemented by other successful organizations is uncertainty (DiMaggio & Powell, 1983). The mimetic pressure derives from organization's need to adapt new technologies, usually when they are poorly understood, by copying the strategy of another successful organization (Chen, et al., 2008).

Normative Pressures: Normative pressures get involved when the organization has to act in a specific way, as a result of expectations created by cultural pressures (Chen, et al., 2008). These pressures derive mainly from professionalization, which involves two basic aspects (Mizruchi & Fein, 1999; DiMaggio & Powell, 1983; Liang , et al., 2007). As DiMaggio and Powell (1983, p. 152) stated, professionalization is defined as: “[...] the collective struggle of members of an occupation to define the conditions and methods of their work, to control the production of the future member professionals, and to establish a cognitive base and legitimization for their occupational autonomy [...]”

Coercive pressures: - Coercive pressures are connected to the organizations enforced identical behavior as a result of laws, regulations and policies implemented by government at the time being (Chen, et al., 2008). In addition, they could derive from formal or informal pressures as a result of professional associations or the competitiveness within the industry (Liang , et al., 2007; DiMaggio & Powell, 1983).

2.2.6 Trends related framework

Before introducing trends found in the literature review, it is better to introduce a general definition of the term, in order to provide a common base to the audience and proceed further. A trend is defined as a general economical, technological, political, societal or industrial tendency (Chen & Lee, 2003). Moving on from this basic definition and then focused on trends related to data center Management. Managers and executives except for dealing with the pressures should pay attention in data center technologies as well since their development is rapid (IO, 2010).

Virtualization: Due to the high costs of data center maintenance and power costs, managers and executives of data centers' need to upgrade their system and try to virtualize everything. This is an ongoing trend. It has found its way into data centers and managers aim to transform their servers or a part of them to extend the benefits that virtualization offers in different areas in the data center. These include hardware such as servers, storage, desktops and platforms. Moreover, a part of this trend leads more and more applications to be transferred in virtual machines, by leading virtualization into the next level, since the functionality of the system is being improved significantly as checked and others in (Clark, 2011; IO, 2010; Preimesberger, 2011; Pfeiffer, 2012).

Consolidation: 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 as checked and others in (Miller, 2011; Pfeiffer, 2012; IO, 2010).

Cloud computing: Could be characterized as a technology that makes IT applications dynamically accessible without any location restrictions. It will continue to develop the next years but as studies show the number of data centers' that cloud computing is being adopted will remain stable. The next few years many data centers will have private clouds and they will use the public ones only during periods of high demand (Preimesberger, 2011; IO, 2010; Clark, 2011; Reeves, 2012; Miller, 2011).

2.3 Initial decision making research model

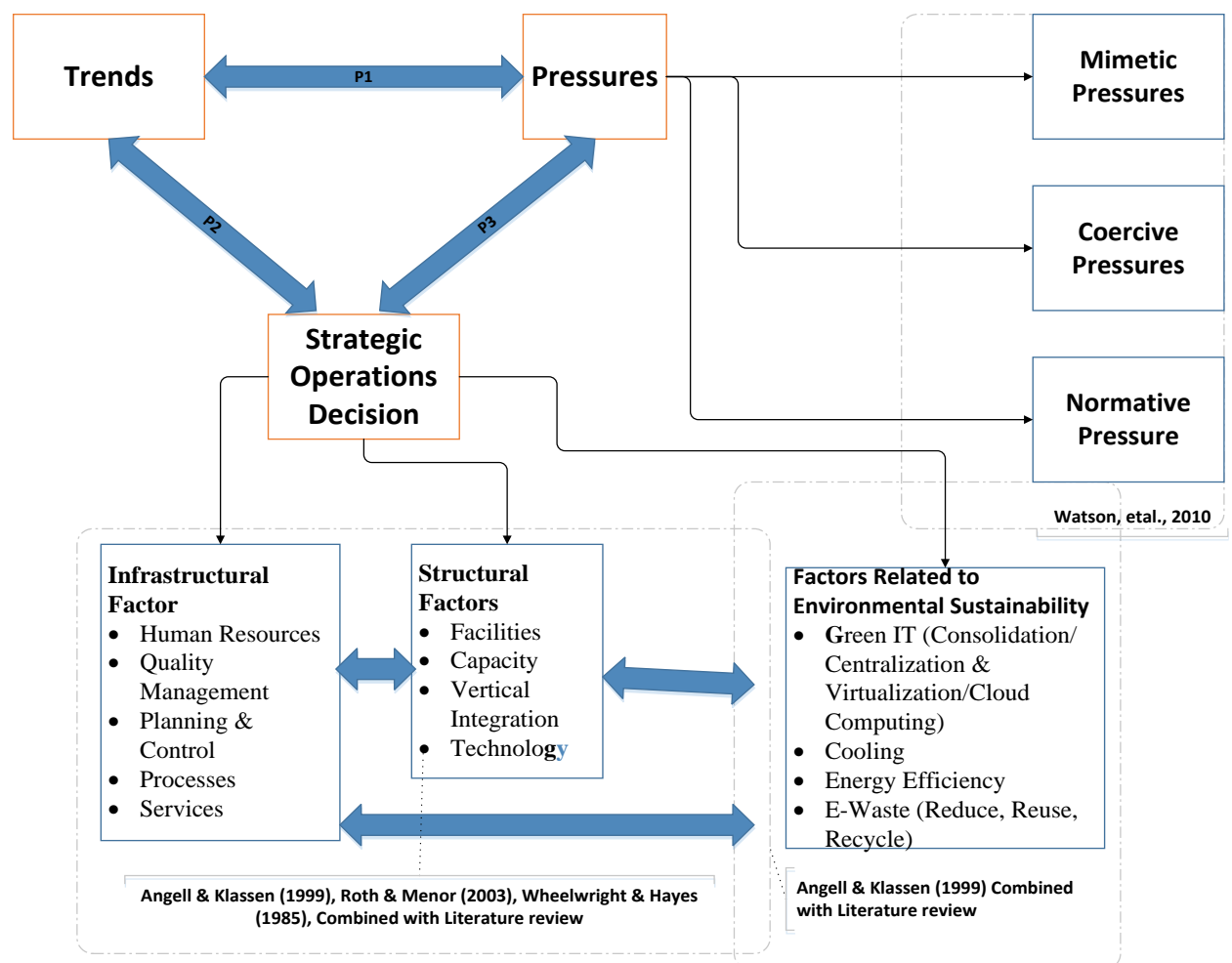
Based on the two-step literature review a research frameworks are established. In order to establish the research framework, the researcher reviewed different available operations management frameworks e.g., Miller and Graham (1981), Amaoko- Gyampah and Meredith, 1989. Although these are valid options, it is decided to combine the frameworks developed by Angell & Klassen (1999), and Roth & Menor (2003) which are based on Wheelwright & Hayes (1985). This is done after reviewing the literature and identifying a pattern in the categorization of the issues and decisions that are related to operations management. Furthermore, Angell & Klassen (1999) extended this framework by adding the dimension of environmental issues. They kept the categorization of structural (Process technology, Facilities, Capacity, Vertical Integration) and infrastructural (Suppliers, New Products, Workforce, Quality Management) operation issues as proposed by

Wheelwright & Hayes (1985) and added pollution control, waste minimization, and the concept of reduce, reuse, and recycle.

In this thesis, the frameworks are combined and included them in the model. In addition, set of propositions (P1-3) are added during the research and these are listed as followings. P1: discussed about Trends – Pressures relationship, P2: discussed about Trends – Strategic Operations Decisions relationship, and the final third P3: discussed about Pressures – Strategic Operations Decisions relationship. These propositions represent the bi-directional arrows between Trends, Pressures, and the Factors that are underlying the Strategic Operations Decisions in the models below.

Figure 2.3 shows the detailed Initial Decision Making Model created by the researcher that is the base for the further research. The boxes that have broken lines drawn around the parts of the research model show how the different frameworks are combined in order to establish the research model.

Figure 2. 4- Initial decision making research model created by the researcher



The model is established through the steps mentioned in the Figure 2.3 and is connected to the research questions of the study as follows:

What trends, pressures and factors affect Strategic ICT data center management decisions for environmental sustainability?

This research question is represented in the decision-making model by the bidirectional triangular connection between trends, pressures and strategic operations decisions. The strategic operations decisions are based on the frameworks of Wheelwright & Hayes (1984), Angell & Klassen (1999), and Roth & Menor (2003) and are based on structural, infrastructural, and environmental factors. Pressures that affect decisions are furthermore specified by using the categorization of DiMaggio and Powell (2003) who introduced a separation into coercive, mimetic, and normative pressures. Trends were incorporated in the research model as general tendencies without categorization.

Is there any prioritization within the factors?

This research question will be answered during the empirical data collection phase. Interviewees are expected to prioritize the factors themselves during the interview process in terms of highly relevant factors and other factors. Although the literature review revealed rankings among factors in terms of how many times they are mentioned in the studies, there is no ranking between factors that are mentioned an equal amount of times. The initial decision making research model represents the finally included factors in an unranked order, in order not to influence the final results.

Do these factors affect each other and if then how?

This research question is incorporated in the initial decision making research model by connecting the structural, infrastructural and the factors that are related to environmental sustainability. Evidence for this is discovered during the literature review and confirmed by the frameworks based on the research model.

What is the role of sustainability in these decisions?

This research question is incorporated in the model by adding Angell & Klassen's (1999) extension of environmental issues to the overall research model. It is represented in the model as the factors that are related to sustainability. The factors relevant to sustainability decisions regarding ICT data centers are identified in the literature review and combined with the issues provided by Angell & Klassen's framework and finally represented in the initial decision making research model.

2.4 Summary of literature review

In this chapter a set of two literature reviews are carried out in the research process. The first literature review is focused on Operation management which is related with data center management. The second literature review a strong interest from the perspective of IT industry is found in chapter 2.2 and indicated by publications such as white papers that are published in large amounts. Sustainability overall and more precisely eco-efficiency, eco-effectiveness, and eco-equity are found is intensively discussed topics in scholar literature as well. The first section starts by defining key works like Green, green IS, green IT and Green ICT. in order links of Green ICT data center with operation management different frameworks are developed from the literature reviews and from the frameworks models are developed. These frameworks are data center management framework, operation management framework. Sustainability overall and more precisely eco-efficiency, eco-effectiveness, and eco-equity are found are intensively discussed topics in scholar literature as well. Factors in strategic operation decisions framework like infrastructural, structural and factors affective the environmental sustainability are discussed the literature frameworks.

Both trends and pressures are used to formulate the frameworks in the literature review. Trends related issues are discussed about virtualizations, cloud computing and consolidation. virtualization which helps to minimize the operation and maintenance costs and power costs. The consolidation discussed about 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. The third trend is cloud computing makes IT applications dynamically accessible without any location restrictions of the data centers. in the literature review three type of pressures are discussed these are mimetic pressures which copies other organizational strategies. The second one is Normative Pressures: get involved when the organization has to act in a specific way. The third coercive pressures are connected to the organizations enforced identical behavior as a result of laws, regulations and policies implemented by government. Finally, by combining the research frameworks provided by (Wheelwright & Hayes (1984), Angell & Klassen (1999), and Roth & Menor (2003) the initial decision Making Model is created to analysis the primary data.

CHAPRER 3: RESEARCH METHODOLOGY

This chapter consists of the following topics research design, population and sampling techniques, type of date and tools/instruments of data collection. Procedure of data collection, and method of data analysis as well as ethical considerations to be addressed under the title “factors Influencing management decision of ICT data center for environmental sustainability in Ethiopia: The case in Ethio-telecom.

3.1 Research Design

The research is expletory survey type. This method was chosen because, due to the study subject matter is fairly new field not much theory exists that could not be tested in quantitative method. Instead, the study was examined what the current literature suggests, as well as applying theories from other fields, and conduct an interview with a people who have practical experience on ICT dana center management or on the subject matter was preferred. In this case, qualitative research methods were more appropriate.

This study is to identify the factors, trends and pressures that the strategic management decision of ICT data center in Ethiopia: The case of ethio-telecom which helps organization to implement Green ICT data center. The research questions are presented, in detail how the research question “what trends, pressures, and factors the management decision of ICT data center?” will be answered.

In order to gain a deeper understanding of the subject matter of the study, literature reviews were undertaken for the foundation of the study. Based on the literature review different frameworks are selected and developed to create the research model. In addition to the literature review interviews with people who work in ICT data center environment has been taken place to get the reality on the ground. The aim of the literature review is to uncover the existing material on ICT data center, and other material that can be applicable to the subject of the study. The interviews, in addition to providing a possibility for preliminary examining the results, to help with general feedback and the status of the existing situation of the of Ethio-telecom data center.

The material was examined in the literature review includes books and articles, other researcher materials but also reports from organizations and governments. As Green ICT data center is a fairly new subject, without an existing, clear foundation, finding good and reliable sources could prove

difficult. One possible strategy is to use material from related fields, and to find the ways in which it can be useful in the field of green ICT data center.

3.2 Population and sampling techniques

For this study, two organizations are chosen. The first one is Ethio-telecom the only telecom service provider in Ethiopia the owner of the ICT data centers. The second one is Ministry of environmental, forest and climate change in Ethiopia which is responsible for the protection of the environmental pollution. Ethio telecom is public sector and large organization in Ethiopia. Ethio telecom owns 6 non-standard or Traditional ICT data centers throughout the country with more than 10,000 ICT equipment's (like servers, routers, switches, power supplies, data storages, cabling materials and cooling system materials. etc) and ET has around 13,000 employees. The researcher attracted by their rapid growth of the IT industry, high level of technological sophistication from time to time that is reflected in the telecom sector but Ethio telecom ICT data center is a traditional data center which did not comply the role of environmental sustainability comparison with Ethiopian proclamations. Proclamation NO. 295/2002 provided for the establishment of environmental protection Organs, Proclamation NO. 299/2002, Environment Impact Assessment and Proclamation. No. 30012002 Environmental Pollution Control Proclamation announced by Federal Gegarit Gazeta of the Federal Democratic Republic of Ethiopia (2002).

Interviews are often used in an exploratory way, and work best for topics that can be talked about openly between people (Macnaghten & Myers, 2007). To answer the research questions of the study, from Ethio telecom ICT data center management perspective semi-structured interview questions are prepared. The interviews to be contacted with three selected relevant interviewees. These are two departments officers and one section manager from Ethio telecom to be selected. The first department is it service design department which is in charge of managing the IT service design of Ethio telecom including design of the ICT data center. The second department is IT service transition which is in charge of managing the IT service project implementation part of Ethio telecom including the data center related projects implementation. The third one is data center management and networking Section which in charge of managing the data centers of ET and the networking tasks of the company.

From the second selected organization for the interview is FDRE Ministry of Environmental, Forest and Climate Change before it was Environmental Protection Authority. This organization is responsible to prepared rules, regulations, standards, policies and guidelines to enforce the

environmental protection in Ethiopia. The selected interview from the second organization responsibility is a senior hazardous waste monitoring and control expert. Even if he is assigned for specific tasks has holistic knowledge on the environmental protection area.

The participants of the study are selected based on expert sampling techniques. Expert sampling is a type of purposive sampling technique that is used when your research needs to glean knowledge from individuals that have particular expertise. This expertise may be required during the exploratory phase of qualitative research, highlighting potential new areas of interest or opening doors to other participants. Alternately, the particular expertise that is being investigated may form the basis of your research, requiring a focus only on individuals with such specific expertise. Expert sampling is particularly useful where there is a lack of empirical evidence in an area and high levels of uncertainty, as well as situations where it may take a long period of time before the findings from research was uncovered. Therefore, expert sampling is a cornerstone of a research design known as expert elicitation by Black, (2010).

Interviews should be used when one wants to get material which provides an in-depth insight into the topic, rather than a wide overview (Denscombe, 2003). They allow a group of people to be chosen, based on their suitability, to take part in the study (Macnaghten & Myers, 2007). Interviews should be used when one wants to get material which provides an in-depth insight into the topic, rather than a wide overview (Denscombe, 2003). The three selected interviewees have an experience with this study of subject matter so they can share their experience about the factors, trends, and pressures affecting the management of ICT data center for environmental sustainability. And also, they are management members of Ethio telecom which can participate on the decision making to move forward to implement the Green ICT data center management. All the selected interviewees have more than six years of experience in the telecom sector, specifically in the information system as well as in the management position. Considering the reason mentioned above expert sampling technique is relevant for this study.

3.3 Instruments/tools of data collection

In order to achieve the objective of the study, the primary data are collected from Ethio-telecom, by the means of semi-structure interview questions. These selected management members in Ethio telecom have data center management related responsibility and they have better understanding on subject matter of the study. From the second organization Ministry of environment, forest and climate

change primary data are collected regarding the environmental sustainability related documents like rules, regulations, standards, polices and guideline what they have and how they enforce the rules and regulations.

The primary data through interview were collected to supplement the analysis the qualitative part of the study. The interviewees from ethio-telecom management group enlightening with related challenges and opportunities of implementing the green ICT data center management in Ethio-telecom, Ethiopia. Semi-structured interview is developed as instrument of primary data collection tools to get necessary information from the target organizations.

The secondary data were collected from literature review, googles scholars, related websites, books, journals articles, and another researcher in this area that are related with ICT data center management for environmental sustainability or Green ICT. The purpose of the secondary data is to find out data that are relevant towards the formation of background information to the study and to create research frameworks and research model.

As the goal of the interviews is to discuss new ideas, rather than testing a theory, qualitative or descriptive, semi-structured interview strategies were chosen. The strategies used in semi-structured interviews include adapting the interview if a new question comes up, and interviewing people more than once (Bryman, 2008). By interviewing some of the participants more than once, changes to the framework can be made and later discussed and evaluated.

Semi-structured, or semi-standardized, interviews are often used in qualitative research, and it is used when the researcher knows about the topic of investigation, but cannot anticipate all possible responses, and therefore may need to adapt the interviews (Morse, 2012). Gillham (2001) explains that interviews can be everything from very unstructured conversations, mainly based on listening to other people 's conversations, to highly structured, questionnaire like interviews. In between the two extremes, different types of semi-structured interviews can be found, where both open and closed questions may be asked. As semi-structured interviews allow a greater flexibility than structured interviews.

3.4 Procedure of data collection

Every procedure of data collection provides a different glimpse of reality and which has limitation when used alone (Neumann,2006). The researcher try to do well to understand types of procedures before undertaking the survey for the problems at hand. Here, the survey is highly valuable for

studying the necessary and relevant information that is useful to conduct a research in the area of the study. The seven stages as proposed by Kvale and Brinkmann (2009) have been followed during the interview preparation. The 7 stages of an interview investigation are schematizing, designing the study, interviewing, transcribing the interviews, analyzing the interviews, verifying the interview findings, and reporting the interview findings

The interview guide is characterized as a list of all the questions that is explored further during the interview. The preparation of the interview guide to be according to the different types of questions proposed by Kvale and Brinkmann (2009) and whenever it is necessary the formulation of the questions has to change according to the background of the interviewee since the same questions do not necessarily mean the same thing for every individual. An interview guide is also a basic component of the interview since it provides a red line to the interviewer to keep track about what topics should be discussed with the interviewee in order to get the responses needed during the interview process (Patton, 1990).

In this study, during the interview session, the interviewer is introduced himself and explained the objective of the study at the same time he asked permission to the interviewees to record the interviews and he was invited to introduce their name & background (includes name, responsibility and position, work experience, educational status, gender, age and marriage status). After the introduction part, based on the semi-structured control question continues to discuss on the subject matter of the study to share their experience and reality of the organization how they handle the management of ICT data center.

3.5 Method of data analysis

In this study, the analysis of the interviews was carryout in a multistep approach. This includes transcription of the interviews, identification, assigning a color codes to identified parts and translating and presenting coded parts in a readable way. Furthermore, the gathered data will be presented in tables forms by categorizing in coherence with the initial decision research model.

1. **Transcription:** - The interviews that carried out were transcribed in the language that is used during each of them. This resulted interviews transcript in Amharic interview was change into English. The Transcription was carried out sticking to the original sentences said by the interviewees. The meaning of the words has however not been changed.

2. Identification: - In order to identify parts of the transcribed interviews that are relevant the transcriptions were thoroughly work through again and again. This was used to identify those parts that are related to the categories - trends, pressures, factors (structural and infrastructural) and factors related to environmental sustainability. Since the interviews are carried out in two different languages (Amharic and English) and only a summary will provide in English the researcher to be discussed the responses of the interviewees thoroughly and analyze them together.

3. Color coding:-In order to make those parts clearly visible in the not translated transcripts the researcher was developed a color code that has then been assigned to the individual parts of the transcribed interviews. This code also was follow the categorization mentioned in step 2 of the interview analysis parts that were coded directly represented important information in the conferring category. The color scheme to identify text parts were provided in table 3.1.

Table 3.1- Color scheme to identify text parts

Category	Color code
Trends	
Pressure	
Factors (Structural/Infrastructural)	
Factors related to environmental sustainability	

Source: compiled from literature review by the researcher

4. Translation and presentation of coded parts: The coded part of the interviews were translated into English in order to presented in a readable form for English speakers and the findings were presented according to the category they belong conferring with the coding scheme. This has been done for all the interviews individually and **was** being presented in chapter 4.3. The researcher was decided to present the data using this approach as he wants to provide the possibility for the reader to get an encapsulated overview about each interview.

5. Extraction in categorized tables, presentation and discussion: In order to present a summary of the research findings the individual interviews were then used to extract the trends, pressures, factors and factors related to environmental sustainability and incorporate them in tables that included an overview table and tables that specifically dealt with the categories mentioned above. The outcome of this process was then assembled in the final decision making research model.

3.6 Research ethics

During the initial contacts with the organizations and the interviewees in order to arrange the interview, the interviewer is expected to inform the potential interviewees about the topic of the research as well as the purpose of the study. Creswell (2007) stated that it is important for the interviewees to be informed prior to the interview and to have the opportunity to decline the interview according to the relevance and sensitivity of the topic. Furthermore, the potential interviewees have been informed that the participation in this study is voluntary at all times ensuring them to the right to quit from the research at one's convenience.

The interviewees could ask in advance, if they want to stay anonymous during the study and moreover they should ask for permission in order to use the name of the organization in the research. In case the interviewee decides not to give the permission, the anonymity of the organization also could not have guaranteed by the interviewer during the study. In addition, the interviewees were informed about the people that have been accessed to the study and the general way of publication of the final report.

CHAPRER 4: RESULTS & DISCUSSION

Throughout the following chapter the researcher was presented the empirical data gathered carrying out semi-structured interviews. The presentation of the data aims to give the incorporation to readers an insight into the findings and to further maintain and expand the chain of evidence in the research. The researcher start by presenting both, the organizations Ethio telecom and Ministry of Environment, Forest, and Climate change of Ethiopia that took part in this research and the individual interviewees. This is done with regard to the differing levels of agreement that are reached in terms of confidentiality for both, organizations and interviewees.

4.1 Background presentation of participating Organizations

The organization that participated in this research is from ICT telecom sector backgrounds. This company is Ethio-telecom which is the only telecommunication service provider company in Ethiopia. the second organization is Ministry of Environment, Forest and Climate change. Thus, the researcher gathered insights into different approaches of how to manage and run a data center operation. In addition, the difference view of interviewees, gave to the researcher the possibility to also explore the difference in importance of factors such as cooling due to different climatic regions and costs and power consumptions. This was also applicable in terms of factors and the difference in size and the sector of operation, of the organization. An overview of the participating organization and organization units is provided in Table 4.1.

Table 4.1 – Participating organizations

Organization Name	Ethio -telecom (A)	FDRE Ministry of Environment, Forest and Climate change (B)
Organization Sector	Public	Governmental
Type of Service	Telecom Service provider	Rules and Regulations for Environmental Protection
Organization Size	Large (above 250 Employees)	Large (above 250 Employees)
Number of Data Centers in your Organization	6	-

Source: Compiled by the researcher from primary data from the interviewees

The organization ethio telecom did not an explicitly defined vision that inherits sustainability. The organization (ethio telecom) has a planned to implement Green Data Center strategy in the coming second GTP of the country, considering the sustainability of the company, and considering the environmental sustainability and social factors.

4.2 Background presentation of participating Interviewees

The interviewees that are chosen from Ethio telecom for participation in this research are all have experienced experts on the data center field and also, they are management members in Ethio-telecom. They have a strong connection and relationship to the data center operations in their organization. An overview about the interviewees is given in Table 4.2.

Note: A and B represents the name of the organization and the numbers 1, 2, and 3 represents the number of interviewees

Table 4.2 – Participating interviewees

No of Interviewees	A1	A2	A3	B1
Position of interviewees	IT service design officer	IT service transition officer	Data center & networking manager	Senior hazardous and e-waste monitoring & control expert
Interviewee Gender	Male	Male	Male	Male
Age	41-50 years	31-40 years	31-40 years	31-40 years
Educational background	Masters	Masters	Degree	Masters
Familiarity with Green Concepts	Yes	Yes	Yes	Yes
Years of experience	6-10 Years	11- 20 Years	11- 20 Years	6-10 Years

Source: Compiled by the researcher from primary data from the interviewees

The selected interviewees are able to provide their personal knowledge and experiences about data center management and where all are aware of the approach of going into ‘green data center. All of them have an experience more than six years in Ethio telecom in information system division which is managed the data center management. The senior expects from the second organization (The

Ministry of Environment, Forest and Climate Change) in Ethiopia is also have an experience in the environmental sustainability subject matter of the study.

4.3 Presentation of interview result

In the following section, the researcher will present the interview results regarding factors affecting the Management decision of ICT Data Center for Environmental Sustainability, trends and pressures in Ethiopia: The case of Ethio Telecom in detail. For this research two organizations are selected. The first one is Ethio telecom which is the owner of the ICT data center. The second organization is Ministry of Environment, Forest and Climate change of Ethiopia which is responsible for the environmental sustainability related agendas. Findings in the interview will be presented in coherence with the research model. Due to the fact that the interviews are carried out in to two languages that developed a color scheme, as presented in chapter 3.3.3, that on top of the textual referencing can be used to identify the parts of the interview that are included in the presentation of each of them. The presented interviews in the following sections represent the readable translations of these color-coded interview parts. The transcribed interviews can be found in the Appendices.

4.3.1 The first interview response

The first interview is carried out with IT service design department officer at Ethio-telecom under Information division. The interviewer granted permission in order to include the name of the organization within the research as well as the occupation of the interviewee. The interviewee is responsible for managing ICT design related tasks including design of the ICT Data center of the company Ethio-telecom. The interview is carried out using face to face communication in interviewee's office in Addis Ababa, Legahar room number 425. In addition, it should be mentioned that the language of the interview is mixed in Amharic and as well as in English but at the end the interview is written in English. The interviewee made it clear during the interview that since Ethio-telecom is a public organization the trends, pressures and factors that are affecting data center management decision are different than the private organizations which offer only data center services. Moreover, the reader has the opportunity to read the summary of the interview in English in Appendix B

Trends related responses: As mentioned by the interviewee during the interview Ethio-telecom did not adapt any the trends in the market like cloud computing, virtualization and consolidation for the

last years. unfortunately, due the fact investment cost restrictions and lack of commitment to transform towards standard data center are the main reasons for the last years that the data center of ET is deployed in the traditional way. Trends such as virtualization and cloud computing are mentioned during the interview. Currently Ethio – telecom did not consider any of the trends neither cloud computing nor virtualization technology which means Green Data Centers that comply with the TIA standards, use of modular and scalable Data Center, Low Power Usage Efficiency, supported with free cooling or water cooling techniques, equipped with cloud infrastructure at all levels, fully automated monitoring and management systems, High fire resistant structure and fitted with automatic suppression system, fitted with all types of sensors and surveillance system, Modern, DCs are built targeting new service opportunities like DC as a service, Infrastructure as a service, PAAS (platform as a service), SAAS (software as a service).

Pressures related responses: According to the interviewee the main pressure for the data center management in the Ethio- telecom is service availability. He stated that it is important to be able to provide services and fulfill the needs of the customers and stakeholders of Ethio-telecom. The existing Ethio-telecom data centers are adopted as equipment rooms and many services are running the decision is always influenced by the need of total Data Center transformation to standardize the way data center is managed. Another pressure mentioned by the participant is the investment cost restriction since the data center belongs to a public sector owned by the Ethiopian government and cost affects all the decisions they need to make and therefore is definitely a pressure for the data center management due to need for new and huge investment to build modern DC. Finally cloud computing is becoming a pressure, which started as a trend but since the technology is changing rapidly they feel the need any more to adopt that technology. In addition, lack of strategic vision and lack of awareness on the important of green data center on the decision makers is other pressure to implement green data center and on the operation of data center management.

Factors responses: - Different factors that affect data center management were mentioned by the interviewee during the interview process. The main factors that were standardization, redundancy, power, availability, cooling, energy consumption, cost, site selection, environmental factors, monitoring and access management, security and reliability. As mentioned by the participant the most important factors were power usage, availability, redundancy and costs. Even though the energy consumption is being taken into consideration it is not possible at the moment to deal with this issue. The participant mentioned during the interview that the Ethio-telecom should deal first with the overall energy consumption and then they were deal with the energy consumed by the data center.

Service availability is one of their priorities since they have been functional and able to provide services to their customers. Of course, the officer made it clear that all the factors they take into consideration were affected by cost and lack of awareness and commitment by the decision makers for support was other challenges.

Factors related to environmental sustainability: In terms of sustainability the interviewee stated that they were not followed a green data center strategy. He was also mentioned during the interview that it is included in their plans to adopt a green strategy in the future since they got approval from decision maker BoD of the company to implement Green data center. As mentioned by the participant their main concern at the moment is to reuse some of the outdated devices in less important systems like test beds that are every time they replace the electronic equipment of the data center, they are considering the characteristics of the device mentioned by the manufacturer and they try to buy the ones which are eco-friendly. Moreover, the equipment that it is not possible to be used by the data center anymore but it is still functioning is being available to sell. The equipment is being placed in Ethio-telecom central warehouse and ready for sell in cheaper price to reuse by other organization or individuals. As mentioned above by the participant they are planning to adopt to implement modern data center or cloud computing technology in the short-term future. As discovered during the interview it was difficult for the last years to adopt green policies since Ethio-telecom financial support did not provide that opportunity but now they have plan to transform to Green data center based on the directions and decision given by the BoD of the company to consider the environmental sustainability.

4.3.2 The second interview responses

The second interview is carried out with the same organization Ethio-telecom and interviewee 2. The interviewer granted permission in order to include the name of the organization within the research as well as the occupation of the interviewee. The interviewee responsibility is IT Service Design Officer under Information Division in ethio-telecom and he is responsible or in charge for IT Service Transition related activities including project implementation/deployment, testing and managing of the data center for customers that include everything from project parts to turn-key projects in Ethio-telecom. The interview is carried out using face-to-face communication in the same office of first interviewee. Moreover, the reader has the opportunity to read the summary of the interview in English in Appendix C.

Trends related response: Interviewee A2 gave an insight about the organization strategy towards trends. According to the interviewee current Ethio telecom data centers are mainly used to deploy telco infrastructure with silo (storage tower) platforms. The main trend of the organization for the future is cloud based data center and that the infrastructure will be virtualized (cloud based). In addition to that data center as a service will bring the biggest revenue share for the telecom as an operator. These trends are then evaluated according to their possible impact in terms of beneficial outcome for the organization. The interviewee made it clear and confirmed that trends can easily develop into pressures that then have to be taken into consideration. There for organizations should aim to adopt feasible trends before they become requirements. Furthermore, energy efficiency is considered a key trend in terms of Sustainability the connection to the organization strategy is just established recently as the organization identified sustainability as a long-term goal in their future strategy to implement Green data center.

Pressures related response: The main pressure for the organization comes from their customers as interviewee A2 pointed out. The main pressures faced in the organization is frequent commercial power failure and air conditioners failure due to this reason the services service is interrupted frequently as a result customers are complained. The second pressure mentioned by the interviewee is scandalization issue of the data centers nowadays Ethio telecom data centers are small scale traditional data centers which do not fulfill the new demands of the organization as well as demand of external customers. As the organization is a telecom service provider managing the operation of data centers, responsible for the planning, implementation, operation and maintenance of telecom data center management for their customers these are mainly defined by the Service Level Agreements (SLAs) that are signed between their customers (venders and users) and Ethio-telecom. These define the maximum number of hours the offered services can be offline, the maximum amount it may take to react, and actively work if a service fails. These SLAs are highly customized contracts that differ largely depending on the core business of the customer and their requirements.

Factors related response: - The main factors that are important and mentioned by the interviewee are location selection of the data center, Power and Environment, Security, quality of services delivered by the Data Center, redundancy, costs, capacity, SLAs, manageability, and human resources. The interviewee made it very clear that on a daily basis and in order to also plan for a longer period the price and the overall costs are the main determining factor. Sustainability is seen more in a sense of how the organization can become economical sustainable than environmental sustainable. The interviewee also connected this again with the trends and pressures. The main factor to implement

trends early or to react to pressures quickly is to lower costs and thus sustain competitiveness. If a positive image can be gained on top of that, this will of course be incorporated in the overall strategy. Furthermore, 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. A major point in terms of establishing and operation a data center is the security of the data itself. This also includes the physical aspect that, depending on the customer, goes as far as from a simpler version of a locked room to a high security facility incorporating newest standards in terms of physical and virtual security, all factored together in a high security perimeter. As mentioned under pressures the SLAs are a key origin of pressure for the organization. Therefore, these are also mentioned as key factors that affect decisions, as all the decisions have to be made in order to converge with the agreements established.

The overall manageability which is affected by all factors mentioned before is crucial as the data center is a complex type of operation. manageability in order to react quickly and. continuously optimize the operation, human resources are a crucial factor to sustain the organizations competitive advantages. Employees are continuously trained and there is a large effort to extend the skills and knowledge of the employees, as this is a key asset in a service organization.

Factors related to environmental sustainability: The interviewee stated that If the data center is not sustainable, the company service will be highly impacted as most of the services are deployed on the data centers. The company has implemented partially a sustainability Strategy. The sustainable strategy does only mean focus that sustainability in terms of environmental factors but also mainly focuses on how the overall company can become sustainable in terms of sustainable relationships between them and their customers, their employees, economical sustainable and then also being sustainable in terms of resources. The interviewee mentioned that a green strategy does not exist so far but for future ET has a plan to implement green data center. Cooling is considered a main factor that is related to sustainability in terms of trying to needing the least amount of cooling possible by designing the data center in the right way, and then consuming less energy by using alternative cooling technologies. Overall a larger awareness and campaigns should be carried out to bring these solutions forward. For new projects this is almost the standard of how to build, taking the circumstances into consideration. The interview pointed out regarding the e-waste issues Ethio-telecom has a partially strategy in place that confers with the principle of reduce, reuse, recycle the outdated ICT products. Hardware that is not needed anymore is reused for less important services or sell to others. Products that reached their end of life cycle are collected to central ware house for sell or for swap the hardware.

4.3.3 The third interview responses

The third interview was carried out with the same organization Ethio-telecom. The interviewer granted permission in order to include the name of the organization within the research as well as the occupation of the interviewee. The interviewee responsibility is Data center and networking Manager under Information System Division in Ethio-telecom. He is responsible to manage Ehtio-telecom data centers and networking activities. The interview is carried out using face-to-face communication in some office of first interviewee. Moreover, the reader has the opportunity to read the summary of the interview in English in Appendix D

Trends related response: As mentioned by the interviewee 3 in the same organization Ethio-telecom during the interview process. The main trends mentioned during the interview are virtualization and cloud computing. They did not implement Cloud Computing technologies and also, they are not considering adapting virtualization. As the interviewee 3 mentioned for the near future Ethio-telecom has a plan to implement modern data center considering the cloud and virtualization technology. In addition to that, interviewee 3 mentioned that taking in to consideration on the efficiency and usage of power utilization is one of the trend to be improved in order to optimized service availability, to minimize the excessive power cost, to consider the environmental sustainability and social friendly. In addition to that the interviewee pointed out other trend is minimization of idle resources needs to be considered.

Pressures related response: The interviewee mentioned that cost were the major pressure. Since everything was by the price of the equipment or technology, even though they want to upgrade their system it was not financially possible without getting permission from BoD. The cost pressure leads many data centers to start operating in different countries in order to be able to reduce their operational costs. Moreover, as discovered during the discussion with the interviewee the Ethiopian government laws and regulations were also affected their decisions since they do not have the opportunity to decide or to act as they wish. They couldn't make a new change on the ICT data center without getting approval from the regulatory body of Ethiopian government. As an example, the interviewee mentioned that they can enter new technologies without getting approval from the regulatory body. Other pressure is commercial power interruption one of the most pressure in ethio-telecom. The interviews also mentioned other pressures during the new project deployment site selection problem which do not consider the availability of spaces to place new systems, availability of power and cooling systems. The limited resources are crucial pressure on the existing Ethio telecom data centers.

Factors related response: As mentioned by the interviewee there are different reasons that affect the data center Management. The major key factors for DC in his view is energy consumption, Space utilizations and Cooling and IT infrastructures utilization. In addition to that he also mentioned Security, site locations, Heat flow pattern within and out of the data center additional factors. Furthermore, the capacity of the data center could be considered as a factor. Ethio-telecom is planning to transform the data center and moreover to construct a new one in another site because the existing data centers are distributed in different site in small scale. The interviewee also mentioned that IT infrastructures selection is a factor to minimized the power consumptions and to maximized the service availability by selecting standard and best IT products taking into account cost benefit analysis.

Factors related to environmental sustainability: The environmental factors they take into consideration by the third interviewee are the renewable energy sources, cooling, green IT, costs and come to standardization. Moreover, the interviewee mentioned that according to government's regulations. The future plan of Ethio-telecom is to transform and to adopt renewable sources of energy in order to reduce the cost. The other factors taking into consideration for environmental sustainability is selection of IT equipment's which have less energy consumption to reduce the high heat production and to reduce the environmental prolusion. The interviewee stated that for the future by deploying Cloud services, using New/State of the art hardware which utilizes less power and dissipate less heat are other factors for environmental sustainability to be considered.

4.3.4 The fourth interview responses

The fourth interview is carried out at the Ministry of environment, forest and climate change of Ethiopia. The interviewee background is a senior hazardous and e-waste expert in the Ministry. The interviewer granted permission in order to include the name of the organization within the research as well as the occupation of the interviewee. Ministry of environment, forest and climate change is responsible to prepared and enforces the rules and regulations, standards, policies and gridlines for environmental sustainability of Ethiopia. The interviewee is responsible for monitoring and control the environmental sustainability from hazardous and e-waste to prevent the pollution. The interview is carried out using face-to-face communication in interviewee's office in Addis Ababa, 4 kilo room number 207. In addition, it should be mentioned that the language of the interview is mixed in Amharic and as well as in English but at the end the interview is written in English. The interview with the fourth interviewee is only focused on the factors related with the environmental sustainability.

Factors related to environmental sustainability: - The interviewer is focused during the interview on the environment sustainability related agendas. Based on that the interview is carried out by explaining the objective of the research to the interviewee. The interviewer asks a general question if they have environmental sustainability related rules and regulations, standards, policies, guidelines, and strategies for the IT products and Services like ICT data center of Ethio telecom. Specifically focused in e-waste materials monitoring & control and GHG emission control related agendas.

The interviewees response: - Proclamations, policies, standards and guidelines are prepared and announced by the Ministry of environmental, forest and climate change of Ethiopia before the organization was as Environmental Protection Authority. The interview pointed out the three proclamations are all related with the subject matter of the study.

The first proclamation is PROCLAMATION NO. 295/2002: A proclamation provided for the establishment of Environmental Organs. It discussed about assigning responsibilities to separate organizations for environmental development and management activities on the one hand, and environmental protection, regulations and monitoring on the other is instrumental for the sustainable use of environmental resource, thereby avoiding possible conflicts of interests and duplication of efforts. It has become necessary to establish a system that fosters coordinated but differentiated responsibilities among environmental protection agencies at federal and regional levels. The second proclamation is Proclamation NO. 299/2002: Environment Impact Assessment Proclamation and Proclamation. And the third one is Proclamation No. 300/2002 environmental pollution control proclamation. Federal gearit gazeta (2002).

In addition to that polices, standard, and guideline documents are prepared, Published and ready to communicate to all stakeholders. For further understanding the readers can refer the website of the Ministry to get the materials. The policy is named as Policy of Ethiopia: the interviewee pointed out that the overall policy goal is to improve and enhance the health and quality of life of all Ethiopians and to promote sustainable social and economic development through the sound management and use of natural, human-made and cultural resources and the environment as a whole so as to meet the needs of the present generation without compromising the ability of future generations to meet their own needs.

4.4 Detailed Analysis and Discussion of Trends, Pressures and Factors

In this section, first the researcher provides an overview of the gathered results during the interviews. Furthermore, he provides a detailed presentation that follows the research model and is therefore split into trends, pressures, factors (structural, infrastructural and factors that are related to environmental sustainability). The results of the research that is found in chapter 4.4.1, regarding the above-mentioned parameters, are then used to establish the final decision making research model of this work.

4.4.1 Discussion of identified trends, pressures and factors by the interviewees

In order to be able to prioritize the trends, pressures and factors identified during the interviews create different tables is important which include all the information given by the interviewees. Each of these trends, pressures or factors is analyzed in two ways. By presenting a percentage value according to the number of interviews that they have been mentioned to find out which of the parameters are seen important by all of the interviewees. Furthermore, prioritize them according to the individual importance and before defined priority that is assigned to the mentioned factors by the interviewees. In the following tables, therefore established a system of coding these two ways of analyzing the data that follows a defined pattern. By assigned the following weights to incorporate the individual importance. A trend, pressure or factor is identified by the interviewee as follows: If the weight is “high important”, value is “5”, If the weight is “important” value is “3”, If the weight is less important the value is “1”, unless “0”. The weighted value is:

$$\sum_{n=A1}^{A3} Weight$$

For the illustration of the non-weighted results, the numerical value and the conferring percentage of the interviews that each trend, pressure or factor to be mentioned and to calculated and can be seen on the tables below. Since the sample size of the research is three interviews from the same organization which have an experience and responsible with the subject matter of the study. Furthermore, it has to be taken into consideration that trends, pressures and factors that are only mentioned by three interviewees can still be the determining parameters for the organization. The researcher want to identify patterns in the responses having the qualitative responses in mind and trying to incorporate them by the system. ‘A’ represents the name of the organization and the numbers 1,2, & 3 represents the number of interviewees.

Table 4.3 – Trends identified by interviewees

Trends	A1	A2	A3	Numerical/ Percentage	Weighted Value	Mean
Virtualization	5	5	5	3/100%	15	5
Cloud Computing	5	5	5	3/100%	15	5
Consolidation		3	1	2/26.67%	4	1.33
Storage	3	3	3	3/60%	9	3

Source: Compiled by the researcher from primary data from the interviewees

Table 4.3 presents all the trends mentioned by the interviewees. In the last column of the table the weighted value calculated by multiplying the number of times a trend has been mentioned by the importance of that trend for the interviewee. The percentage column represents the percentage of the interviewees that mentioned each trend. The trends are being presented on the table randomly. Interviewees A1-A3 pointed out that virtualization and cloud computing are trends that they want to follow. The weighted value of 15 out of 15 indicates that this trend is of high importance.

By examining table 4.3 according to the interviewees the trends with the highest importance are virtualization and cloud computing (weighted value: 15). On the other hand, important storage (9) and consolidation (4) is being considered by less data centers.

Table 4.4 – Pressures identified by interviewees

Pressures	A1	A2	A3	Numerical/ Percentage	Weighted Value	Mean
Service Availability	5	5	5	3/100%	15	5
Costs	5	5	5	3/100%	15	5
Government policy	3	3	3	3/100%	9	3
Laws / regulations	3	3	1	3/100%	7	2.33
Customers (external/internal)	3	3	3	3/100%	9	3
Investors	2			1/33.33%	2	0.67
SLA	3	3	3	3/100%	9	3

Source: Compiled by the researcher from primary data from the interviewees

In table 4.4 the pressures identified during the interviews are being presented. These pressures are introduced in the presentation of interview results regarding trends, pressures and factors and factors

related to environmental sustainability (section 4.3). The interviewees mentioned different pressures which affect their decisions. Each of these pressures will be included in the final decision making research model and will be assigned to the conferring type of pressures identified in the literature review. All of the interviewees agree that service availability, costs, disaster recovery, internal customers and external customers are the important pressures (A1-A3). On the other hand, government, SLA, internal/external customers and regulations, seem to be more important to the interviewees that work for the public organization and the foundation under public law (A1, A3).

The weighted values of Table 4.4 rank the identified pressures mentioned by the interviewees according to the following order: costs (15), service availability (15), internal customers (9), external customers (9), slas (9), governments policy (9) laws/regulations (7), and investors (2).

Table 4.5 Factors identified by interviewees

Factors	A1	A2	A3	Numerical/ Percentage	Weighted Value	Mean
Reliability	5	5	5	3/100%	15	5
Speed	5	5	3	3/100%	13	4.33
Energy consumption	5	5	5	3/100%	15	5
Technology	5	3	3	3/100%	11	3.67
Cooling	5	5	5	3/100%	15	5
Costs	5	5	5	3/100%	15	5
Organizational management		3	2	2/66.67%	5	1.67
Security	3	5	5	3/100%	13	4.33
Customers (External)	5	3	1	3/100%	9	3
Customers (Internal)	5	5	3	3/100%	13	4.33
Human Resource	3	3	1	2/66.67%	7	2.33
Quality Management	3	3	3	3/100%	9	3
Data center management	3	1	3	3/100%	7	2.33
Capacity	5	3	3	3/100%	11	3.67
Virtualization	1	1	1	3/100%	3	1
Consolidation		1	1	2/66.67%	2	0.67

Availability	5	5	5	3/100%	6	2
Storage	5	3	1	2/100%	9	3
Facility SLA	5	3		2/66.67%	8	2.67
Location/Site selection	5	5	5	3/100%	15	5

Source: Compiled by the researcher from primary data from the interviewees

Table 4.5 represents the factors mentioned by the interviewees that affect strategic management decisions. All these factors will be examined and will be added to the final decision making research model. The model will be presented in the next section of this chapter. The interviewees mentioned 20 factors in total during the interviews and 10 of them could be considered as high important across all interviewees in this research. According to the interviewees important factors are availability, cooling, costs, reliability, technology, organizational management, security, external customers and capacity since their weighted value is between 11 and 15.

The weighted values of table 4.5 rank the identified factors mentioned by the interviewees according to the following order: availability (15), cooling (15), costs (15), location (15), reliability (15), energy consumption (15), speed (15), security (13), customers (internal) (13), capacity (13), technology (11), facilities (9), data center management (9), customers (external) (9), quality management (9), slas (8), human resources (7), virtualization (6), organizational management (5), storage (4), & consolidation (2).

Table 4.6 – Factors related to environmental sustainability identified by interviewees

Factors	A1	A2	A3	Numerical/ Percentage	Weighted Value	Mean
Reuse	5	5	3	3/100%	13	4.33
Reduce carbon emission	3	3	3	3/100%	9	3
Recycle	3	1		2/66.67%	4	1.33
Green IT	5	3	3	3/100%	11	3.67
Green Strategy	3	3	3	3/100%	9	3
Facility	3	1	1	3/100%	5	1.67
Costs	5	5	5	3/100%	15	5
Image	3	3		2/66.67%	6	2
Energy Consumption	5	5	5	3/100%	15	5

Cooling	5	5	5	3/100%	15	5
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Source: Compiled by the researcher from primary data from the interviewees

The weighted values of Table 4.6 rank the identified factors related to environmental sustainability mentioned by the interviewees according to the following order: Costs (15), Energy Consumption (15), Cooling (15), Reuse (13), Green IT (11), Reduce (9), Green Strategy (9), Image (6), Facility (5), and Recycle (4),

From the above results, most of the interviewees agree that costs, cooling, reuse and energy consumption and Green IT are the highest important factors related to environmental sustainability with a weighted value between 11 and 15. Reduce and Green strategy are being considered as important factors with a weighted value 9. Furthermore Recycle, facilities and image have less important from the respondents and have a weighted value between 4 and 7.

4.4.2 Final decision making research model

After completing the data analysis of the information provided by the interviewees the researcher the final decision making research model which is based on the initial decision making research model. In this model, all the trends, pressures and factors identified in the literature review and moreover mentioned by the interviewees are included. The findings are categorized according to the literature review and finally the propositions for the bi-directional arrows between trends, pressures and Strategic Operations Decisions have been revised. This model is a combination of the findings during the literature review and the responses given by the interviewees.

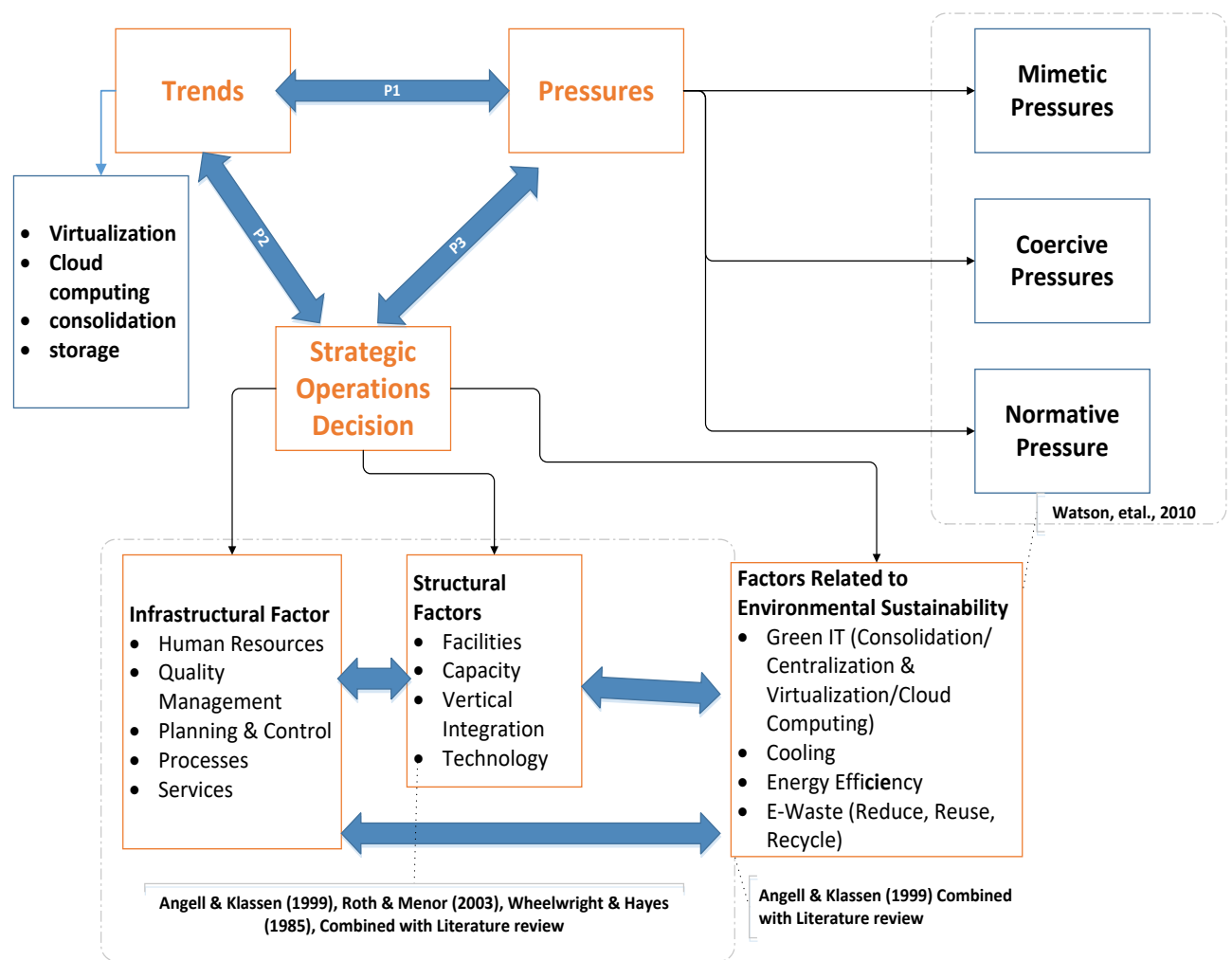
According to the second chapter of the research, strategic operations decisions are divided to structural factors, infrastructural factors and factors related to environmental sustainability. The relevant factors identified during the literature review are categorized, analyzed and presented in the second chapter of the thesis. Moreover, in the fourth chapter the readers have the opportunity to see the presentation and analysis of the interviewees' responses relevant to factors and factors related to environmental sustainability. As proposed by the interviewees and in addition verified by the literature review some of the identified factors are relevant in more than one category. As it can be seen in the final decision making research model, costs are a factor that is relevant in all categories. They are valid in terms of a structural factor, infrastructural factor and as a factor related to environmental sustainability. It should be mentioned that the factors identified in the literature review are also presented in the model.

During the literature review the researcher come up with a set of propositions which are presented in the initial decision making research model. The propositions are presented by bi-directional arrows in the model which

represent the relationship between trends, pressures, and the Strategic operations decisions. these relationships are examined during the interviews and the researcher could not find enough evidence in order to support the bi-directional relationship. this however does not lead to the conclusion that there is no such connection. it can be taken as a possible future research area. during the interviews, it is managed to identify that trends could turn into both, pressures and factors of importance for strategic operations decisions. in addition, according to the interviewees pressures could develop into strategic operations decisions. as an example, in the model the researcher can notice that pressures coming from internal and external customers as well as trends such as cloud computing could affect strategic operations decisions.

In Figure 4.1 the final decision making research model is being presented. In this model trends, pressures and factors identified in the literature review and also mentioned by the interviewees are categorized and presented. The changes from the initial research model in figure 2.3 are indicated by underlining them in the box and by changing the line pattern of the propositions.

Figure 5.1- The final decision making research model created by the researcher



CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

In this chapter, the researcher present several conclusions that come up with upon finishing the analysis of the data. The researcher start by answering the initial research questions based on the findings in the literature review and primary data that is gathered from interviewees.

1. What trends, pressures and factors affect Strategic Data Center Management decisions?

A data center is a complex operation that is affected by many trends, pressures and factors. The trends, pressures and factors that are of importance have to be seen in combination with the organizations type and sector of operation. Also, the size of the organization has to be taken into consideration. The most important trends that are verified in the empirical data are virtualization and cloud computing. In addition, trends in the area of storage and consolidation are added after investigating the data. Pressures are seen to be imposed on the organizations from all three dimensions (mimetic, coercive, and normative). These pressures included service availability, costs, government, laws/regulations, SLA, customers (internal/external), and others.

Factors that are considered relevant for the strategic operations decisions are found to be diverse throughout the involved interviewees in the organization. While the basic factors necessary to run a data, centers are regarded as being found across all the interviewed respondent, other factors such as more expensive or technologically advanced solutions are seen relevant only in coherence with the organization limitations in terms of e.g. costs. This may be depending on the organization backgrounds.

2. Is there a prioritization within the factors?

There is a prioritization within the factors. As analyzed in the previous chapter and as it can be seen in table 4.7, the different interviewees in the organization have almost similar priorities in their data center operations. Factors that have been seen as highly relevant by the interviewees, according to the researcher weighted value system, are Availability (15/15); Costs, Cooling (13/15); reliability, technology, organizational management, security, customers (external) and capacity (9/15). However, it still cannot be claimed that these are the overall most important factors for a data center operation, as the background and requirements for each individual operation differ.

3. Do these factors affect each other and if then how?

Regarding the questions of relations between factors it can be said, that the overall factor that affects all the other ones are costs. Also, this can be seen in the fact that costs occur in all of the factorial categories (structural, infrastructural, environmentally sustainable) as it can be seen in the final decision making research model in section 4.4.3. Out of the Analysis in chapter 4.4 it can be said that this is even more relevant for the public owned organizations. The large organizations that are private or public limited have more freedom to decide and possibilities to take decisions that focus on e.g. long term benefits such as a lower energy consumption, building new data centers using sophisticated technologies. Factors that are related to Sustainability have effects on both, structural and infrastructural factors and are linked to them, as it can be seen in the final decision making model. Infrastructural and structural factors affect each other in the way of structural factors often building the base for the infrastructural factors. On the other hand, infrastructural factors make use of their structural base and contribute to changes in this base.

4. What is the role of sustainability in these decisions?

During the interview the interviewees come up with factors that they relate to sustainability in terms of their ICT data centers. Also with concepts that are in place in order to follow a green strategy. These are presented in chapter 4. However, the role of environmental sustainability in the data centers of the participating interviewees is found to be nonstandard. Overall all of the interviewees said that the most important and priority thing for them is the up and running data center operation. Although aware of the green concepts the impression has been gained that all of the interviewees have a strong relation to or in-depth knowledge about possible benefits. Even then it is taken as something that comes along with the other advantages such as increased availability due to new hardware that is also more energy efficient. These advantages are then gained as a bi-product, when taking e.g. procurement decisions for their data center. The organization for the future have strategies in place to promote itself as being “green” and to compliance with the standards of green data centers. This also helps their data center management decisions.

5.2 Limitations

In general, the publications in the IT industry about sustainable data centers are increasing, and the manufacturers themselves focus a lot on providing e.g. energy efficient solutions, the implementation of such is not seen as a goal when taking strategic operations decisions by the participating data center

responsible. It is seen as something that comes with the process, but not something that they go ahead with. However, it is depending on organizational backgrounds in terms of size, origin, and area of operation involved as the researcher wants to get different viewpoints. This brought insights from different angles representing the individual data center professional's view of their daily operations. It is therefore not justifiable to generalize to a larger amount as already done, among them.

Finally, the aim of this research is to identify trends, pressures, and factors that affect strategic data center management decisions. This strived to incorporate the aspect of environmental sustainability. The researcher provides a decision-making research model that can be mainly taken as a starting point for future researchers. It also can be taken into consideration by data center professionals in terms of providing initial guidance about factors that should be considered in their data center operation.

5.3 Recommendations

Having collected the data and developed the final decision making research model, it would now be time to move on to verify the trends, pressures and factors on a quantitative level leading to a representative prioritization of the factors that are connected to strategic data center decisions. This could then also be done in regard of sustainable aspects. With a focus on Sustainability this could then be incorporated into a management model for Green data centers. Also, could further research be carried out to examine the propositions that is mentioned in the final decision making research model between trends, pressures and factors, for further clarify the status of these relations.

- As the researcher mainly focused on environmental sustainability further research could be carried out in terms of the relation of environmental with economic sustainability and with social responsibility in ICT data center operations.
- The researcher recommendations to Ethio telecom: The company should be implement standard Green ICT data center phase by phase to consider the environmental sustainability, to save operational and maintenance costs and to take into account social responsibilities by optimal utilization of resources and to compute with the world class operators.
- The researcher recommendation for the Ministry of environmental, Forest and Climate change of Ethiopia even if they prepared the rules and regulations like proclamations, policies, standards and guidelines but proper communication and training to all concerned are remaining tasks expected to enforces the environmental protection rules and regulations.

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APPENDIX A: INTERVIEW QUESTIONS

Semi-structured interview questions

For the interviewees from Ethio telecom and Ministry of environmental forest, and climate change of Ethiopia both semi-structured interviews and closed loop questions are prepared. The closed loop questionnaires help to the researcher to know the background of the organizations and the respondents. The Semi-Structured interview questions are main body the interviews helps to the researcher to gather the research primary data.

Short general block of questions:

Part I: General information regarding professional background of the Interviewees or respondents.

Tick ✓ symbol for the correct answer.

Part II: General information about the company/operations background

Part III: Detailed questions matching the research questions: For Ethio telecom respondents

1. What are the key factors that have to be considered in a data center?
2. What additional factors do you think are important?
3. Does your company use a managerial framework (standards, best practice) for managing your data center(s)?
4. What are the main pressures that affect your data center management decisions to consider sustainability strategy and how?
5. Are you following the development of trends relevant for your data center?
6. What are currently the main trends and what would you say are upcoming trends in the next decade in the data center industry?
7. Have you adapted a trend early on, before it became a pressure/threat?
8. Is Sustainability considered a factor in your data center?
 - a. If not, then why is not considered as a factor?
 - b. If yes, in what way do you consider sustainability in your data center?
 - c. If yes, which are the main benefits for your operations being sustainable (e.g. cost savings/improvement of image)?
9. What role do technologies such as green IT (virtualization, consolidation, centralization and cloud computing) play in your data center?
10. Do you measure your data center Energy Efficiency?

- a. If yes, how do you measure this power usage efficiency (PUE), data center infrastructure management (DCIM))?
- b. What is the role of cooling regarding your data center energy efficiency?
- 11. Is an e-waste strategy part of your data center Policy (reuse, reduce, recycle)?
- 12. Do you have a certification for “green data center management” (the green grid, CompTIA strata green IT)
- 13. Which of the mentioned factors are the most important ones?
- 14. How do the mentioned trends and pressures affect your decisions (factors) to implement Green data center strategy?
 - a. What conflicts do you think are most prominent in the relationship of the mentioned?
 - b. What are conflicts that you have experienced regarding this triangle in your organization? The triangle means in this context trends (virtualization, consolidation, centralization and cloud computing), pressures, and factors that affects the management of ICT data center for environmental sustainability.
- 15. Do you think that there is a connection – negative or positive – between the mentioned factors?

For Ministry of environmental, forest and climate change in regard to sustainability of the environment interview question.

Part III: Detailed questions matching the research questions: Factors related to environmental sustainability questions:

1. Does your organization have rules and regulations, policies, standard and guidelines for ICT organization like Ethio telecom to consider the environmental sustainability period deployment IT products?
2. Does your organization have an **e-Waste** (recycle and reuse) rules and regulations and policy for ICT or IT devices/equipment?
3. Does your organization have a standards and guidelines for ICT Data Center to prevent pollution?
4. Does your organization have a standards and guide lines to enforce the stakeholders for Green IT Energy Consumption to minimize pollution of the environment?
5. Does your organization have a communication channels with the stakeholders to create an awareness and to enforces the policies on environmental protection or environmental sustainability?

APPENDIX B: Transcription of Interview 1

Interviewee 1: Nafie Mohammedseid (IT service design officer)

Organization: Ethio Telecom (Telecommunication service provider)

Interviewer: Hailu Haftu

Summary in English

The interviewee one is IT service design department head in Ethio telecom. He is in charge of managing IT service design related tasks including data center design. As he mentioned during the interview the main factors that affect data center management are the speed, standardization of DC, cooling, availability, redundancy, power, cost, site selection and energy consumption. pressures mentioned during the interview are existing Ethio telecom data centers have been adopted as equipment rooms and many services are running the decision is always influenced by the need of total DC transformation to standardize the way data center is managed, the second pressure is the need for new and huge investment to build modern DC and final pressure is lack of strategic vision of the higher decision makers are pressures mentioned during the interview. The main trends mentioned by the interviewee are cloud computing and virtualizations to move towards Green Data centers that comply with the TIA standards. Modern DCs are built targeting new service opportunities like DC as a service, Infrastructure as a service, PAAS (platform as a service) and SAAS (software as a service) some of the existing trend mentioned during the interview. To maintain the sustainable environment to move towards standardization is crucial. modern DCs are characterized by their lower PUE value less 1.3, cooling system optimization, clearly defined electronic-waste policies and strategies are the main factors mentioned by the interviewee.

APPENDIX C: Transcription of interview 2

Interviewee 2: Tsegaye Emanuel (IT service transition officer)

Organization: Ethio telecom (telecommunication service provider)

Interviewer: Hailu Haftu

Summary in English

The interviewee two is IT service transition department head in Ethio telecom. He is in charge of managing IT Service project implementation related tasks including Data Center related projects. As he mentioned during the interview the main factors that affect data center management are the availability, security, service level agreement (SLA), redundancy, power and environment, site selection and human resources (experts on the domain). Some of the pressures mentioned during the interview are lack of system automation to monitor the data center (DC), frequent failure on the power and Air conditioners and so many small data centers (No standard data center as big operators) mentioned by the interviewee. The main trends mentioned by the interviewee, currently data centers are mainly used to deploy telco infrastructure with silo platforms. And the next trend is cloud based data center and that the infrastructure will be virtualized (cloud based). Final trend data center as a service will bring the biggest revenue share for the telecom as an operator. Environmental stationarity factors mentioned during the interview by the second interview as follows: In the trend of the Data center, Green IT is the main advantages of deployment of the data centers. All technologies support for cost saving. Traditional data centers are very expensive as most of the platforms are silo. Each platform has its own power and environment consumption. But if the infrastructure is based on Green IT technologies the maintenance and initial investment cost can be saved and the environmental sustainability to be considered.

APPENDIX D: Transcription of interview 3

Interviewee 3: Seid Degu (data center and networking manager)

Organization: Ethio Telecom (Telecommunication service provider)

Interviewer: Hailu Haftu

Summary in English

The interviewee three is data center and networking section manager in Ethio telecom. He is in charge of managing Ethio telecom data center and networking related tasks. As he mentioned during the interview the major key factors for DC in my view is energy consumption, space utilizations, cooling, IT infrastructures, power, security and site selection. Some of the pressures mentioned during the interview are Frequent power interruption and new projects deployment especially site selections mentioned by the interviewee. The main trends mentioned by the interviewee cloud computing and virtualization are the trends in relation to power consumptions and resource utilizations in minimizing idle resources. Environmental stationarity factors mentioned during the interview by the third interviewee as follows: by deploying cloud services, using new/state of the art hardware which utilizes less power and dissipate less heat. By implementing green IT strategy (virtualization, consolidation, centralization and cloud computing) makes high availability and less resource utilization minimizing idle resources based on traffic and in addition to that the environmental sustainability to be maintained as per the interviewee mentioned.