

**How important are Green Environmental issues in Data Centre locations for
Cloud Service Providers (CSPs) and for Small and Medium Enterprises (SMEs)?**

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Dublin Business School
excellence through learning

Word Count: 18,674

August 2014

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Declaration

This dissertation is being submitted in partial fulfilment of the requirements for the degree of MBA in Cloud Computing at Dublin Business School (www.dbs.ie).

This dissertation is the result of my own independent research work, except where otherwise stated. All other sources are acknowledged in the bibliography section. This dissertation work is not submitted in any other form to any other organisation or institute.

- Dharmendra Ungarala

Acknowledgements

I would like to acknowledge my sincere thanks and obliged to a number of people who have been part of this dissertation and for my MBA.

I would like to thank DBS for giving me an opportunity to do an MBA degree.

Thanks to all of my family members who directly or indirectly helped me to complete this dissertation and my MBA, especially to my father – **Bhaskara Rao**, my mother – **Vimala**, Wife – **Devi**, Son – **Yaswanth**, Brother – **Havaladar Krishna Murthy** and Sister – **Jyothi**.

I would like to express my gratitude to my dissertation supervisor **Michael Gleeson** who supported me continuously and provided a clear guidance throughout the dissertation process.

I would like to thank those individuals – Vishy, Jashuva, Kala and Venkat who took time off from their busy work schedules to participate in interviews.

My sincere thanks to Brid Lane and all other DBS Professors - Dr.PJ Paul, Brendan Barrett, Claire Devlin, Michael Kealy, John Staunton, all of my MBA classmates and specially Abhishek, Chikondi, all of my friends and all of DBS non-teaching staff particularly Librarians.

Abstract

The purpose of this dissertation is to assess on how important are Green Environmental issues in Data Centre locations for Cloud Service Providers (CSPs) and Small and Medium Enterprises (SMEs)?

This dissertation work is based on two sources, primary data and secondary data. The primary data has been collected by four interviews whereas the secondary data has been collected from several sources such as journal articles, books and internet (websites of various companies and websites of energy and environmental bodies).

The literature review provides the main themes and theories of the topics under Green Cloud Computing. This review suggests that there are many ways to save energy in Data Centres through hardware and software techniques. Also found natural cool locations can help in a significant level to decrease the energy usage and to get Total Cost of Ownership (TCO).

Primary data was collected through qualitative methodology (semi-structured interviews). Deductive approach is used and followed Interpretivism as a philosophy.

This research provides several key points concerning environmental consequences due to Cloud Data Centres, how important this environmental aspect to CSPs in setting up their Data Centres in Green Zones, how important this environmental aspect to SMEs while selecting a CSP, is it Green Cloud Computing a selling point for CSPs? Results are positive towards setting up Green Zones, following all the power optimisation techniques right from the design of a Data Centre. The study concludes that Cloud Service Providers initiatives towards environment make a positive effect on Small Medium Enterprises that could be an indirect selling point to CSPs.

Abbreviations

APJ	: Asia Pacific and Japan
CRT	: Cathode Ray Tube
CSP	: Cloud Service Provider
CSR	: Corporate Social Responsibility
DBS	: Dublin Business School
DNA	: Deoxyribonucleic acid
EMCS	: Energy Monitoring and Control System
EMP	: Electromagnetic Pulse Protection
EU	: European Union
GHG	: Green House Gas
HVAC	: Heating, Ventilation and Air Conditioning
IaaS	: Infrastructure as a Service
ICT	: Information Communications Technology
IGCA	: Integrated Green Cloud Architecture
IPCC	: Intergovernmental Panel on Climate Change
LCD	: Liquid Crystal Display
LED	: Light Emitting Diode
LPARs	: Logical Partitions
NCDC	: National Climatic Data Center
NESDIS	: National Environmental Satellite, Data and Information Service
NIST	: The National Institute of Standards and Technology
PPP	: Public and Private Partnership
PUE	: Power Usage Effectiveness
R&D	: Research and Development
RECs	: Renewable Energy Credits
SCADA	: Supervisory Control and Data Acquisitions
SEAI	: Sustainable Energy Authority of Ireland
SLA	: Service Level Agreement
SLOs	: Service Level Objectives

SMEs : Subject Matter Experts
SMEs : Small and Medium Enterprises
TCO : Total Cost of Ownership
UCD : University College Dublin
UI : User Interface
UN : United Nations
UNEP : United Nations Environment Program
USA : United States of America
VM : Virtual Machine
WMO : World Meteorological Organization

Chapter 1 – Introduction

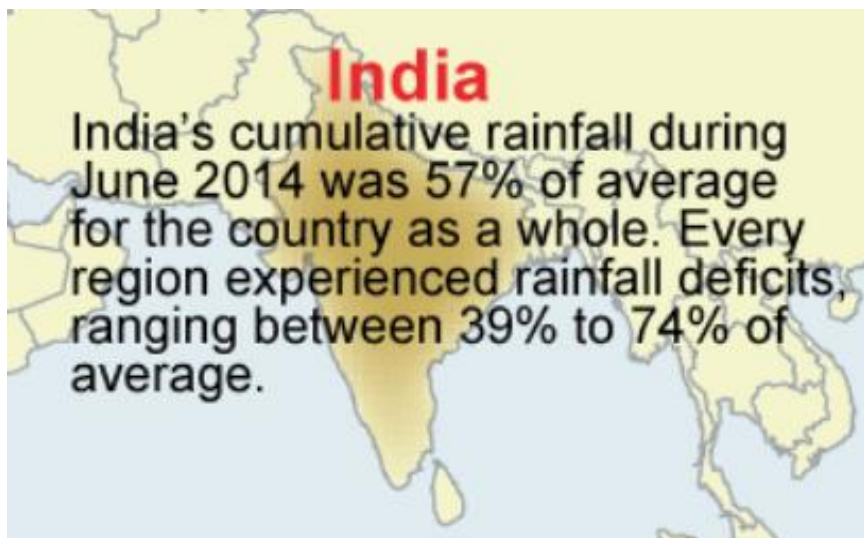
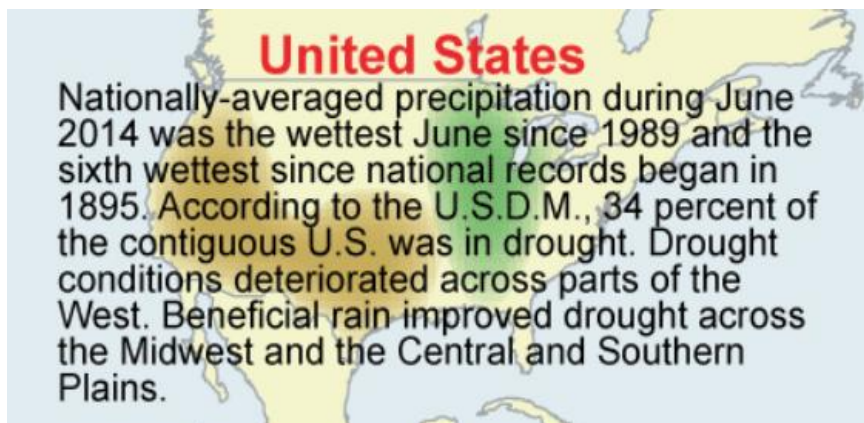
1.1 Background

This dissertation topic is a mix of more technical (Cloud Computing) and non-technical (Environmental aspect). This mix gives an interest on the topic. Let me start with the present world environment situation then move to the importance of Green Cloud Computing from different aspects. Assess the importance of Data Centres in natural cool locations and is it Green IT a selling point to Cloud Service Providers.

One of the most strongly debated topics on Earth is the issue of climate change. The National Environmental Satellite, Data and Information Service (NESDIS) data centers are central to answering some of the most pressing global change questions that remain unresolved. “The National Climatic Data Center (NCDC) contains the instrumental and paleoclimatic records that can precisely define the nature of climatic fluctuations at time scales of a century and longer. Knowing how these systems are changing and how they have changed in the past is crucial to understanding how they will change in the future. Internationally, the Intergovernmental Panel on Climate Change (IPCC), under the auspices of the United Nations (UN), World Meteorological Organization (WMO), and the United Nations Environment Program (UNEP), is the most senior and authoritative body providing scientific advice to global policy makers. The IPCC met in full session in 1990, 1995, 2001 and in 2007. They address issues such as the build up of greenhouse gases, evidence, attribution, and prediction of climate change, impacts of climate change, and policy options.” (NCDC, 2014)

According to the NIST “Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” (Mell and Grance, 2011).

Selected regions (US, Europe, India, Australia)



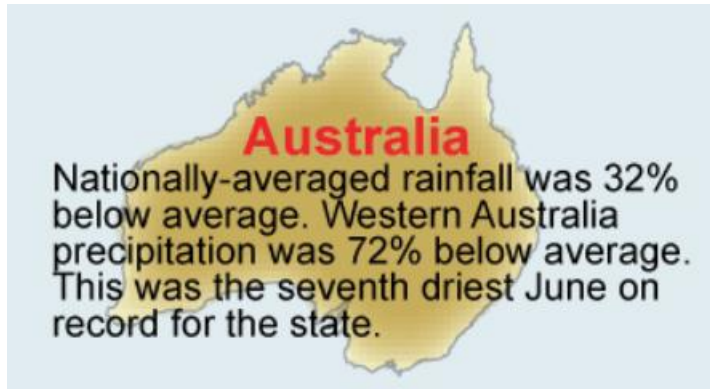


Figure 1: Significant Climate Anomalies and Events - June 2014

State of the Climate - Global Highlights – June 2014

- The combined average temperature over global land and ocean surfaces for June 2014 was the highest on record for the month, at 0.72°C (1.30°F) above the 20th century average of 15.5°C (59.9°F).
- The global land surface temperature was 0.95°C (1.71°F) above the 20th century average of 13.3°C (55.9°F), the seventh highest for June on record.
- For the ocean, the June global sea surface temperature was 0.64°C (1.15°F) above the 20th century average of 16.4°C (61.5°F), the highest for June on record and the highest departure from average for any month.
- The combined global land and ocean average surface temperature for the January–June period (year-to-date) was 0.67°C (1.21°F) above the 20th century average of 13.5°C (56.3°F), tying with 2002 as the third warmest such period on record. (NCDC2, 2014)

How much energy is required to power the ever-expanding online world? What percentage of global greenhouse gas (GHG) emissions is attributable to the IT sector? Answers to these questions are very difficult to obtain with any degree of precision, partially due to the sector’s explosive growth, a wide range of devices and energy sources, and rapidly changing technology and business models. It is highly impossible to ‘Switch off/shutdown’ the mission critical systems like Air Traffic Control, Defense Navigational Systems, Medical informatics, Nuclear power, Banks and other financial institutions, Aeronautics, E-commerce and online transaction processing systems.

Patterns of use of electricity:

- Data centers in the U.S. consumed 61 billion kWh of electricity in 2006—1.5% of total electricity consumption—at a cost of \$4.5 billion.
- The peak load on power plants associated with servers and data centers was about 7 gigawatts (GW) in 2007. Updated technologies can reduce server energy use by 25% or more, while using best management practices with existing equipment can reduce energy use by around 20%.
- Computers and office equipment accounted for 15% of the total electricity consumption (211 billion kWh) of office buildings in 2003.
- In 2011, 76% of households in the U.S. had a computer or a tablet, compared to 51% in 2000. Globally, 488 million smartphones, which have capabilities similar to computers, were sold in 2011, up from 174 million in 2009.
- From 2005 to 2009, the proportion of primary household computers that were laptops doubled, rising from 22% to 44%. More than 14% of primary household computers were used 10 hours or more a day in 2009. (Center for Sustainable Systems, 2013)

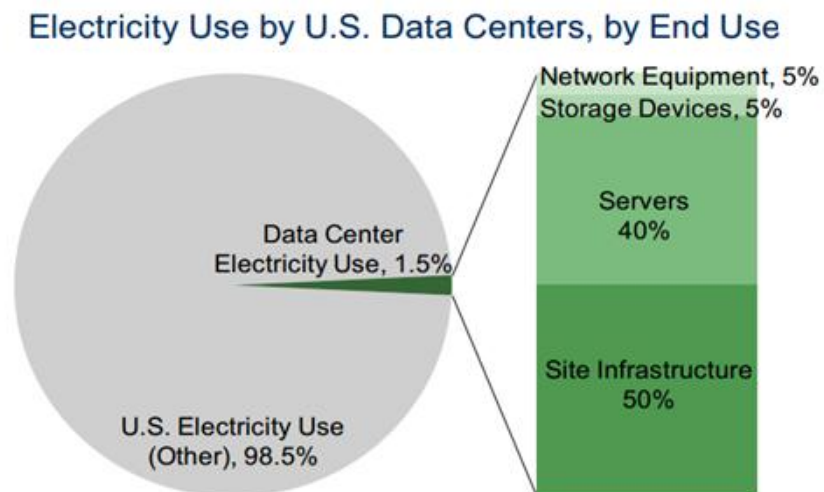


Figure 2: Electricity Use by U.S. Data Centers

“Facebook, Amazon, Apple, Microsoft, Google, and Yahoo – these global brands and a host of other IT companies are rapidly and fundamentally transforming the way in which we work, communicate, watch movies or TV, listen to music, and share pictures through “the cloud.” The growth and scale of investment in the cloud is truly mind-blowing, with estimates of a 50-fold increase in the amount of digital information by 2020 and nearly half a trillion in investment in the coming year, all to create and feed our desire for ubiquitous access to infinite information from our computers, phones and other mobile devices, instantly.” (Greenpeace, 2012).

Energy and Environmental Impact

- Approximately 74.5 billion lbs of CO₂ equivalent emissions are released annually due to electricity used by U.S. servers & data centers.
- Electricity consumption of computers varies greatly with age, hardware, and other factors. An average desktop computer uses 70W when active and 9W in low power mode. Laptops use significantly less energy—about 19W when active and 3W in low power mode.
- A 17” cathode ray tube (CRT) monitor uses 61W when active, 2W in low power mode, and 1W when off. A 17” liquid crystal display (LCD) monitor uses 35W while on, 2W in low power mode and 2W when off.⁸
- The annual life cycle burden of a computer is 5,600 MJ. Only 34% of life cycle energy consumption occurs in the use phase; extending the lifetime could mitigate the energy burden of the production and disposal phases. (Center for Sustainable Systems, 2013)

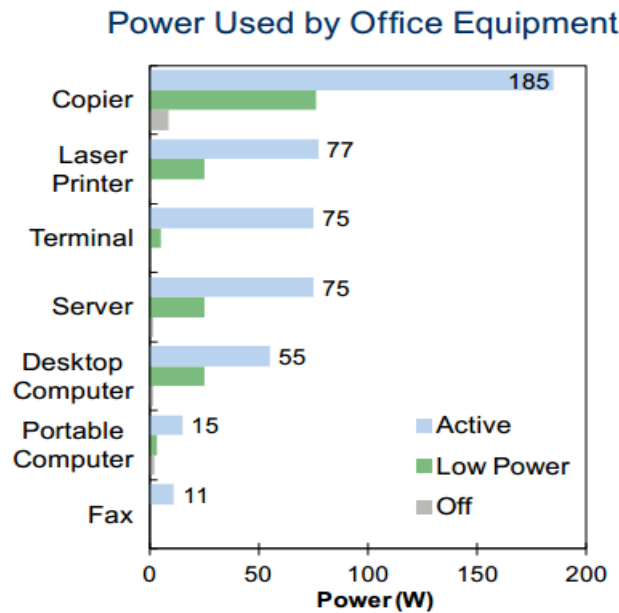


Figure 3: Power used by office equipment

The energy efficiency of cloud computing has become one of most pressing issues. “An Integrated Green Cloud Architecture with a Middleware component enables company manager to balance the job operations’ execution efficiently in terms of minimum energy consumption to private /public clouds or based on user’s request.” (Hulkury & Doomun, 2012)

1.2 Research Aim and Questions

“It is often a useful starting point in the writing of research questions to begin with one **research question** that flows from your research idea. This may lead to several more detailed questions or the definition of research objectives. Objectives are more generally acceptable to the research community as evidence of the researcher’s clear sense of purpose and direction.” (Saunders et al, 2012, p.43)

The purpose of the dissertation is to analyse on how much could Green IT reduce GHG emissions to mitigate global warming? Compare hardware-oriented optimization, software systems oriented optimization can be potentially achieved at development stage by setting their power characteristics and adapting the implementation.

- How important are Green Environmental issues in Data Centre locations for Cloud Service Providers (CSPs) and Small and Medium Enterprises (SMEs)?

Question Rationale: To understand the view of CSPs and SMEs on Data Centre location can make a difference in Environmental aspects.

- Is Green IT a selling point along with other attributes like SLAs, price, availability, security, support?

Question Rationale: To understand the factors affecting to CSPs and SMEs with Green IT.

1.3 Researcher specific angle outline

Although Cloud Computing has rapidly emerged as a widely accepted computing paradigm, at the same time it suffers from different challenging issues related to security, quality of service, standardization and power consumption. Efficient energy management is one of the most challenging research areas.

More and more research in Green Cloud Computing and genuine care for the environment must come from all the cloud vendors to make this planet clean and green by keeping the physical location of Data Centres at naturally cooled places, through hardware and software.

1.4 Approach to the dissertation

The approach to the dissertation undertaken by the researcher to get the complete understanding of the Green Cloud Computing a selling point from provider's perspective and how natural energy (wind and solar) and natural cooling locations of Cloud Servers help the environment.

1.5 Suitability of the researcher and interest in the subject

"Your research topic must be something you are capable of undertaking and one that excites your imagination. Capability can be considered in a variety of ways like time and finance. Capability also means you must be reasonably certain of gaining access to any data you might need to collect." (Saunders et al, 2012, p.28)

The choice of this subject is explained by the fact that the researcher is interested to know natural cool locations can help Data Centres to use low energy and he is also concerned about environment and to find cost effective ways to save money to Cloud Service Providers/vendors. Cooling expenses of Data centres are

crossing the cost of hardware. To assess that, is Green Cloud Computing a selling point like other selling points – price, availability, security, performance and support. The researcher is animated by the desire to know more about the current trend of SMEs while choosing their CSPs.

1.6 Limitations of the research

The scope is defined as the context of the study topic. The researcher must stay honest with himself regarding his work. There are always limitations which have to be mentioned and taken into consideration.

Limitations: Limitations are composed by several elements such as unpredictability event which could happen even if all the indicator of the environment are showing the opposite signs of relief or concern about the next few years.

Others limitations could be mentioned here:

- The number of interviews has been limited due to the difficulty to meet or have contact with eminent experts and environmentalists. In four interviews and that the research has made, there are no environmentalists.
- Due to the time restriction, secondary data may not be large enough.
- In general, there only few people who are ready to assume the fact there is a risk of a worst environmental situation will arise, so it has been more difficult to consider these arguments.

1.7 Organization of the dissertation

This dissertation is framed into 5 chapters. The chapters are described as below:

Chapter 1 – Introduction

Introduction to illustrate the interest of the subject and to highlight what it will intend to achieve in this study. Through this first part, it has been mentioned the approach, the aim of this research with objectives.

Chapter 2 – Literature Review

The literature review critically examines the existing theories & literatures related to Green IT that supports different point of views and help to understand the

SMEs perception on environmental situation while choosing their CSPs. This chapter is based on several writes and thoughts of eminent professionals of the World environment and Green Cloud Computing subject areas.

Chapter 3 – Research Methodology

This chapter deals with how the research methodology has been followed and what kind of research methods have been used for this study. It discusses the research philosophy, approach, choice of data collection and analysis techniques that was used in conducting this research. It allows the reader to better understand how this dissertation has been done.

Chapter 4 – Research findings and Data Analysis

The Research findings and Data Analysis part presents what the researcher has found through several in-depth semi-structured interviews. From these interviews, the researcher reports each argument relative to the subject in order to complete his understanding of the overall research question.

Chapter 5 – Discussion

This chapter allows reviewing the work and interpreting results, to discuss the implications of findings. A discussion is a commentary, not a reiteration, of the results. Refer back to research questions and literature review and discuss how the research has contributed to the area. Demonstrate awareness of the limitations of this research; be critically evaluative of this work. A good discussion is structured, comprehensive and concise.

Chapter 6 – Conclusion and Recommendations

The aim of this chapter is to bring conclusions by summarizing the findings from the data analysis chapter. At the end of this part, findings are pointing out the way in which these particular findings clarify the issues.

Chapter 2 - Literature Review

2.1 Literature Introduction

The literature review chapter contains themes that provide the background for the fundamental topics of this research study. It reviews existing concepts, theories and overall conclusions of the literature. Each theme is explored with the aim that it links into the research questions and research objectives that have been outlined for this study. A total of themes have been used in this thesis. First one is, 'build energy-efficient hardware and SLAs perspectives'. Second one is about 'optimize the underlying technologies of the cloud, such as virtualization'. Next one is about 'location aspect – Is it Server Location Matter for CSP or SMEs?' Last one is about 'CSPs aspect - Is it Green IT a selling point along with other attributes?' The literature review section concludes with an overview of the essential findings and provides an insight into the chosen methodology of the research.

Two major reasons exist for reviewing the literature (Sharp et al. 2002 cited in Saunders et al 2012, p.70). The preliminary search that helps us to generate and refine our research ideas. The second, often referred to as the 'critical review' or 'critical literature review', is part of your research project proper.

The literature review constitutes the secondary data source for the dissertation and identifies the main themes and theories of the topics under investigation. Maylor and Blackmon (2005, p.81) said that the purpose of the literature review is to both support the research topic and to define the research question. "The literature review ensures that the research question is grounded in the existing research and there will be coherence between the literature review and the rest of the dissertation." (Andrews, 2004, pp.17-18).

Hart (2005, p.3) gives an additional insight and explains that a further purpose of searching the literature is to identify work that has already been done or in progress that is relevant to this research, to help design the methodology and to identify key issues and data collection and analysis techniques. This section presents the themes and issues that are relevant to the emergence of a critical understanding of Green Cloud Computing. How Green Cloud Computing techniques helping the environment? How Green IT affects the sales of CSPs as it is one of a selling point? How Data Centres siting/location is important to CSPs and SMEs?

Wallace and Wray (2011) cited in Saunders et al, 2012, p.75 advocate the use of five critical questions to employ in critical reading. These are:

1 Why am I reading this? (The authors argue that this is where the review question is particularly valuable. It acts as a focusing device and ensures that you stick to the purpose of the reading and do not get sidetracked too much by the author's agenda.)

2 What is the author trying to do in writing this? (The answer to this may assist you in deciding how valuable the writing may be for your purposes.)

3 What is the writer saying that is relevant to what I want to find out?

4 How convincing is what the author is saying? (In particular, is the argument based on a conclusion which is justified by the evidence?)

5 What use can I make of the reading?

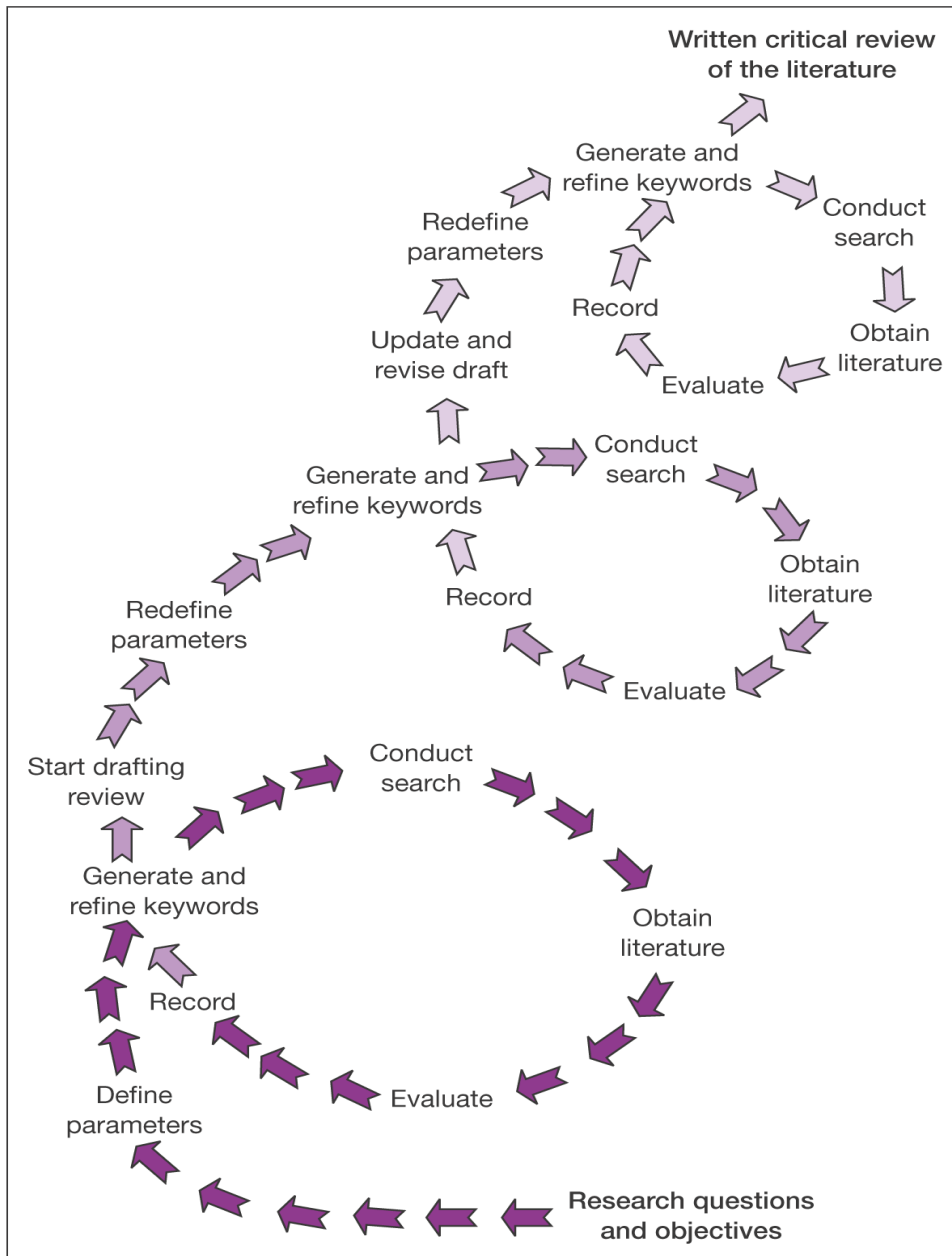


Figure 4: The literature review process

(Source: Saunders et al, 2012, p.72)

2.2 Build energy-efficient hardware and SLAs perspectives

According to Chauhan and Saxena views on SLAs are, the cloud IT infrastructure has many complex systems and a large pool of high-performance computing resources and high- capacity storage devices. Multiple cloud customers share these resources, which CSPs can provision as needed. Because scalability is a key cloud characteristic, CSPs must keep buffer resources to meet the customers' changing requirements and SLAs. There are two issues with respect to cloud IT

infrastructure. The first deals with having energy-efficient hardware and computing devices. The second focuses on optimally using hardware to minimize energy resources without compromising performance and security (Chauhan & Saxena 2013).

Lango says that SLAs specify enterprise service-level requirements, often in the form of a legal contract between provider and consumer, with penalties for non-compliance. Concrete and measurable service-level objectives (SLOs) are individual metrics used to test that an SLA is being met. The availability component of an enterprise SLA can be technically challenging. For example, a business-critical application might not tolerate more than five minutes of downtime per year, conforming to availability SLO of 99.999% (“5 nines”) uptime. In contrast, resources in the public cloud have unit economics falling somewhere between enterprise and commodity hardware components, including relatively high expected failure rates. Amazon’s virtual block devices, for example, have an advertised annual failure rate of 0.1%–0.5%, meaning up to 1 in 200 will fail annually. Enterprise application performance needs vary. End user facing applications might be managed to a specific response-time SLO, similar to a consumer Web application measured in fractions of a second. Important business applications such as ERP and financial analysis might be managed to both response time and throughput oriented SLOs, supportive of specific business objectives such as overnight trading policy optimization. Security requirements vary by application category but generalize as risk management: the higher the business or regulatory value of an application or dataset, the more stringent the security requirements. (Lango, 2014)

Chauhan and Saxena further added that Cloud customers expect a certain level of service from their cloud service provider (CSP). The customer and CSP usually agree upon the details in advance via a service level agreement (SLA). SLAs are stringent for applications that require high performance. They can affect the quality of service expected from cloud providers and influence the cloud’s energy consumption. For example, if a mission-critical application requires high availability, the CSP must keep failover and backup resources running constantly to meet the SLA, negatively affecting energy consumption because some backup resources consume

energy even when not in use. Including energy-related terms and conditions in the SLAs is another way to track energy consumption in the cloud. Cloud customers and providers can outline SLA terms regarding energy-usage limits and responsibilities. Energy consumption beyond such limits should be recorded, and parties should be penalized for SLA violations. There can be mechanisms to award or transfer carbon credits to cloud stakeholders based on SLA adherence (Chauhan & Saxena 2013).

Data Center Power Usage Effectiveness (PUE):

“Defined as the ratio of overall power drawn by the data center facility to the power delivered to the IT hardware. This is a location specific data center efficiency metric that accounts for energy consumption of active cooling, power conditioning, lighting, and other critical data center infrastructure. Many cloud providers utilize a multitenant approach by relocating the redundancy of traditional models into a central location; using dedicated equipment specifically allocated to the individual customers. When capacity is allocated in terms of installing and activating additional servers for a customer, server utilization rates are effectively lower than in the multitenant model that allocates server processing cycles not server hardware units.” (Salesforce.com, 2011).

“The Energy Monitoring and Control System (EMCS) and Supervisory Control and Data Acquisitions (SCADA) systems provide all of the sensors and calculations required to determine real-time efficiency measurements. All measured values should be continuously trended and data archived for a minimum of one year to obtain annual energy totals. An open protocol control system allows for adding more sensors after initial installation. IT equipment often includes on-board temperature sensors. A developing technology includes a communications interface which allows the integration of the on-board IT sensors with an EMCS.” (Energy Efficiency & Renewable Energy, 2011)

How does Cloud Computing reduce the Environmental impact of IT?

To understand the potential advantage of cloud computing in more detail, it is important to look at the distinct factors contributing to a lower per-user carbon footprint. These factors apply across cloud providers in general and are even relevant

for many on-premise scenarios. This level of understanding can thus help IT executives target additional efficiency gains in an on-premise environment and realize additional performance advantages in the future.

“The comparatively smaller carbon footprint of cloud computing is a consequence of both improved infrastructure efficiency and a reduced need for IT infrastructure to support a given user base. In turn, these primary levers are heavily influenced by four key factors (see the following Figure)” (WSP, 2010)

Figure : Key Drivers of Cloud Computing's Reduced Environmental Footprint

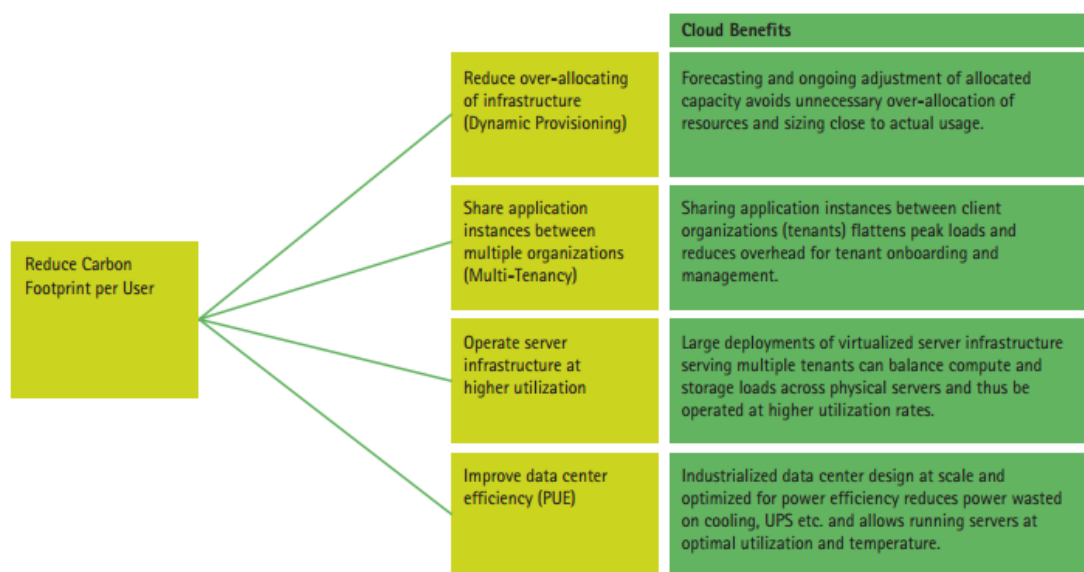


Figure 5: Key Drivers of Cloud Computing’s Reduced Environmental Footprint

2.3 Optimize the underlying technologies of the cloud, such as virtualization

“Virtualization technology began with the virtual memory of mainframe in the late 1960s. Since then, virtual storage, physical partitioning, and hypervisor technology to support dynamic partitions have been launched in the IT market. Like this, new virtualization technologies led by in mainframe have been introduced step by step in many fields. It is fair to say that the history of server virtualization is the history of mainframe which had led virtualization technology. Virtualization has four basic functions for resources: Sharing, Aggregation, Emulation, and Insulation.” (Lee Yong & Kim Hwan, 2014)

“Virtualization is the first step to adopting the cloud. Services of the Cloud are made available through virtualization and provided on a usage-based pricing model. These resources can be quickly provisioned and easily managed, by the user, without any major inputs from cloud service provider. The cloud pool is a virtualized way of using computer resources. A cloud is useful in various jobs performing approach in which they can include the concept of aggregation and association. Allow workloads to be deployed and scaled-out quickly through the rapid provisioning of virtual machines or physical machines. Support Redundant, self recovering, highly scalable programming models that allow workloads to recover from many unavoidable hardware/software failures. Monitor resource use in real time to enable rebalancing of allocations when needed. We do not say that the cloud is only the collection of system resources because it is more than this thing because cloud also provides a mechanism to manage those resources. Management includes provisioning, change requests, reimaging, workload rebalancing, de-provisioning and monitoring.” (Patel, 2012)

“Virtualization enables many independent data servers to run software and/or operating systems on one physical server. This technology allows companies to greatly reduce the number of physical computer servers needed and better utilize each server; each machine can run at 80% rather than 10% capacity. Virtualization reduces material waste, electricity use, space, costs, and heat generation, benefiting both the environment and a business’s budget.” (Center for Sustainable Systems, 2013)

Virtualization Effect:

Virtualization benefits can vary as per the potential virtualization user goals or their approach methods, adopted technology and the existing IT infrastructure types. Most users can have the benefits mentioned below 1) ~ 8), even when simply using the server integrated virtualization. Also, when the users make more efforts in their IT infrastructure virtualization, the potential virtualization benefits can be attained as well with corresponding rate. The potential benefits that can be attained in inducing the virtualization are as follows:

1) Higher utilization rate in the resources: virtualization enables the active sharing for the physical resources and the resources pool, through which the utilization rates of the higher resources can be achieved. Especially, in the variable work load situations with the average work load that is much less than the overall resources work load, the higher effects can be expected.

2) Lower management cost: virtualization improves management resources' productivity by reducing the number of the physical resources that have to be managed. Physical resources' complexity reduction simplify the common management tasks through the automation, informationisation and centralisation enables the automation in the work load management Also, virtualization allows the management tools function in the species platform environment as well.

3) Usability: virtualization allows the resources to be dynamically reorganized and utilized to meet the business needs in the fast paced work environment.

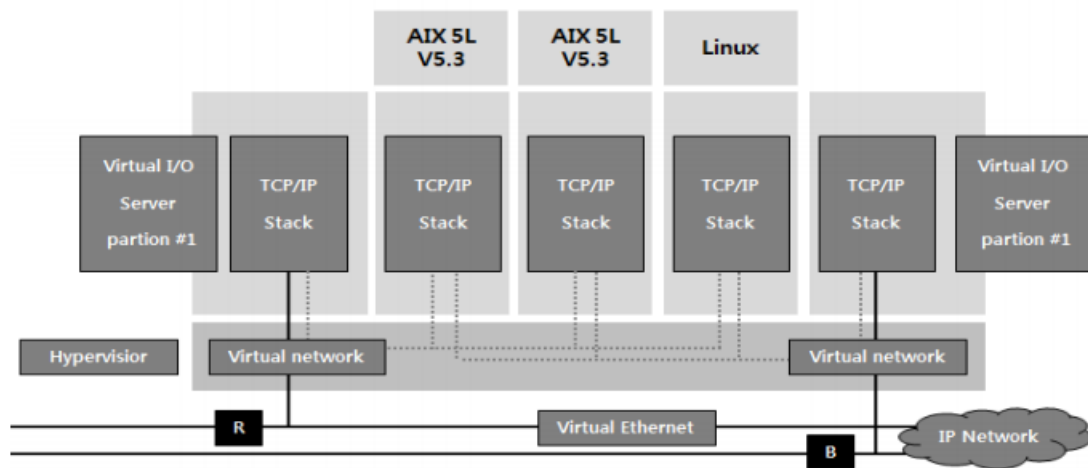
4) Improved security: virtualization allows the separation that isn't achieved easily in the simple sharing mechanism for the data and services and provides safe access.

5) High fusibility: virtualization supports the removal, upgrading, or changing the physical resources without influencing the user level.

6) Increased expandability: resource LPARs and Aggregation enable the virtualized resources to become smaller or bigger than each of the physical resources, through which the proper expandability can be achieved with no change in the physical resources.

7) Interoperability and investment protection: virtualization resources offer compatibility of the interface in the protocol level that can't be achieved among the existing physical resources.

8) Improved provisioning: virtualization enables the resources allotment within the more detailed part units rather than in the individual physical unit. (Lee Yong & Kim Hwan, 2014)



(Source: Lee Yong & Kim Hwan, 2014)

Figure 6: Flow of Virtual Communication

“Cloud computing and virtualization have become research hotspots in recent years. Since information communication technology is widely used in real life, data centers have rapidly been developed and the number of data centers has increased a lot. However, the existing data centers have too much power consumption. The energy and resources utilization are much lower. Against this backdrop, green computing is proposed. In IaaS cloud platform, service consumers give hardware and software configuration of virtual machines (VM) to be created and used to cloud platform, and perform the assignments on their custom VM. If the submitted jobs are parallelizable, the VM may require multi-core for more efficient execution. In many cases, some customers may need to execute a clustered application service which involves inter process communication with a low-latency demand. Such services and applications will also require multi-core architecture. It is suggested that once virtual machines are configured, created and launched onto the appropriate host, they will begin executing the jobs. The speed at which a VM processes the assignment depends on the speed of the computing resources on which the VM is launched as well as the internal scheduling policy associated with the host. Since the cloud customers and subscribers expect explicit SLA on computer resources, storage and networking infrastructure, a high-efficient scheduling and placement policy to map the incoming VM instances onto a right fit infrastructure is necessary.” (Lian, et al, 2013).

2.4 Location aspect – Is it Server Location Matter for CSP or SMEs?

Many factors go into choosing a location for new cloud computing infrastructure. “Data center siting requires the adequate availability of reliable and affordable electricity, as well as telecommunications infrastructure. Tax incentives, climate, and proximity to end- users may entice a company to choose a particular location. Availability of renewable energy to power the data center, while possibly considered, is currently low on most cloud companies’ lists. As these data centers continue to multiply and increase their electricity consumption, access to renewable sources of electricity must be prioritized across the sector.” (Greenpeace, 2012).

Datacenter facility

CSP companies must pursue datacenter design strategies that can help reduce carbon footprints. Using dirty energy sources such as coal to meet CSP’s datacenter energy requirements is a major concern. CSPs need to

- Adopt clean and renewable energy source, such as solar, wind, ocean, and hydropower
- Develop cost-effective and environmentally friendly power-generation mechanisms
- Store energy to better use energy sources and avoid waste.

“The design, construction, and maintenance of facility buildings in datacenters greatly affect the environment and natural resources. Cloud facilities are huge, often consuming significant energy to meet lighting, cooling, and other operational requirements. Such facilities need green buildings that use environment-friendly materials and processes and that are resource-efficient throughout the life cycle.” (Chauhan & Saxena 2013).

CLUMEQ is a Supercomputer Consortium Laval UQAM McGill and Eastern Quebec. “The **CLUMEQ** supercomputing center in Quebec has worked with **Sun Microsystems** to transform a huge silo into a data center. The cylindrical silo, which is 65 feet high and 36 feet wide with two-foot thick concrete walls, previously housed a Van de Graaf particle accelerator. When the accelerator was decommissioned, CLUMEQ decided to convert the facility into a high-performance computing (HPC)

cluster known as Colossus. The **CLUMEQ Colossus** cylinder features an interior “hot core” (as opposed to a hot aisle) in the center of the building and uses the outside ring of the facility as the cold air plenum. The cabinets are arranged in a ring on each floor, facing the outside of the silo. The floors supporting each ring of cabinets are comprised of grates rather than solid flooring to facilitate airflow through the facility. The cooling coils and air handlers are located in the basement. Chilled air flows upward through the outside cold aisle and through the racks of servers. The waste heat exits the rear of the racks into the hot core, and is returned to the basement via the cold aisle. The air flow pattern is maintained through differential air pressure – maintaining a higher air pressure in the cold aisle than the hot aisle. This keeps the air moving through the facility, which has a blowing capacity of 180,000 CFM and can cool up to 1.5 megawatts of electrical load. **Up to 300 kilowatts of cooling capacity can be supplied by ‘free cooling’ using fresh air from outside the facility.**” (Data Center Knowledge, 2009)

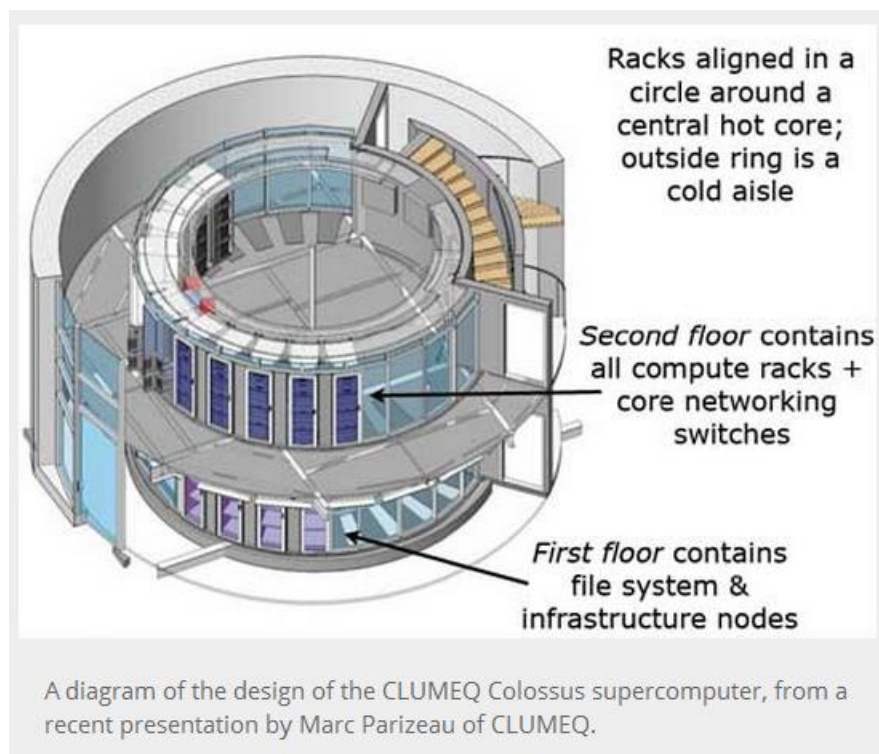


Figure 7: Design of CLUMEQ Supercomputer that uses natural cooling temperatures

“Lefdal Mine Datacenter is one of the world’s most energy effective datacenters. The cooling solution will lead to a PUE ranging from 1.08-1.10. 3% of the power spent on IT is used for cooling given 5KW/rack. The solution is based on cold

seawater used as cooling source through a heat exchanger for a closed fresh water circuit that cools computers via the integrated cold air radiators. The proximity to the fjord ensures access to unlimited 7, 5 C seawater year around. The fjord is deep (565 meters) and has 4 glaciers connected to it. The mine is situated just below sea level so there is no need to use energy lifting the water. The seawater will cool down the fresh water circuit from 30 C to 18 C and enter back into the fjord at 12 C. Experts have verified through research that this will have no impact on the marine life due to the size of the fjord and the tide. In Lefdal Mine Datacenter we can offer a cooling solution that runs on 3% of the power needed to operate the IT hardware. IBM/CH2M HILL have in their report concluded that the Lefdal Mine cooling solution runs with an industry leading PUE under 1.1. The cooling solution offers 20-30% improvement over current leading edge designs operational or under construction in Europe. Conditions in Norway are conducive to Norway becoming a “superpower” for green datacenters. Large amounts of 100 % renewable energy at a leading price level in Europe and free cooling makes Lefdal Mine extremely cost effective. Add excellent infrastructure, stability, high competence and the world’s largest space and you have Lefdal Mine - The Norwegian solution! Lefdal Mine has been funded by the Ministry of Governmental Administration and Reform and by Innovation Norway. Lefdal Mine is also supported by the Ministry of Trade and Industry. The Government together with the industry recognizes that Norway is about to become a leading global player within the area of data handling and Lefdal Mine is the leading datacenter facility in Norway. The total power production in the area is presently 12.7 TWh (100 % renewable). The planned capacity for the data center will be ramped up in steps as the project develops.” (LeafdalMine, No date)

Green Power: 98.5 % of total power production is Hydroelectricity. Norway produces nearly twice as much renewable energy as any other Nordic country. Increasing production ensures lower prices.

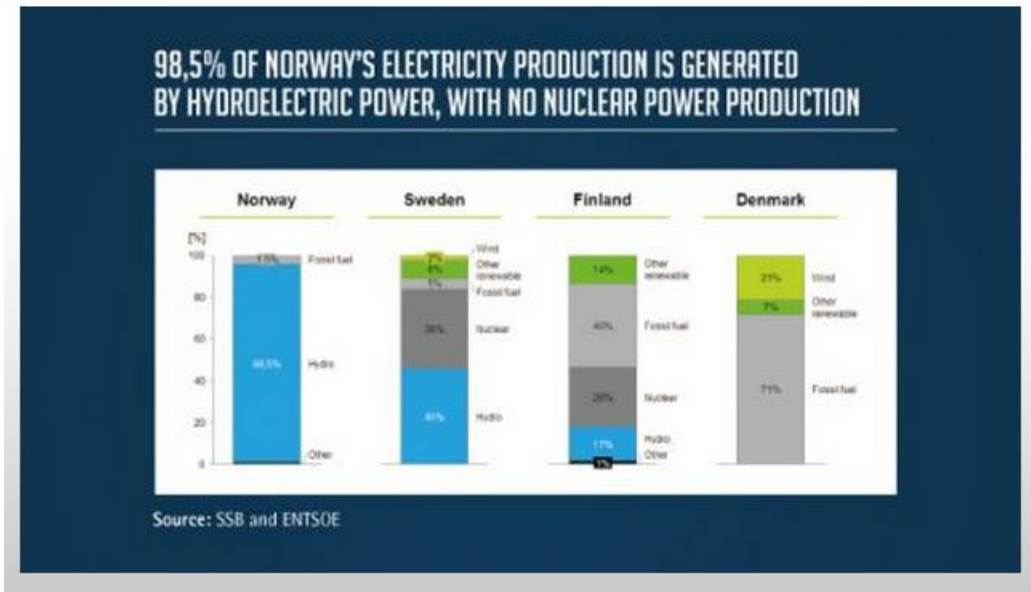


Figure 8: 98.5% of Norway's Renewable Electricity Production

2.5 CSPs aspect - Is it Green IT a selling point along with other attributes?

Going green can have an impact on your customers through other, more indirect methods, as well. According to the Harvard Business Review on Green Business Solutions, green buildings promote “lower utility costs, greater employee productivity, less absenteeism, and stronger attraction and retention of workers” (Lockwood, 2007.) While those gains don’t have to be reiterated, what might be noted is the effect green buildings have on improving the work experience for the employee and the implied transitive effects those might have on customer sales and services. “The ways in which a business can integrate sustainability and environmentally safe practices are as varied as the species of flora in the rainforest. Many companies have tried to switch to paperless systems of payments and/or customer notifications, utilizing emails and electronic bill-pay management web systems. Other companies have switched to using only recycled materials. This is another selling point as customers want to deal with companies that want to deal with them which can translate into a better customer experience and a stronger company. If this idea sounds elementary, it’s because it is, but it remains effective.” (Triplepundit, 2012)

Green Cloud Computing is still in its initial stage and it still we have to explore lot of things which are still not known or not explored. “Cloud computing need not

just remain confined to e-mail servers and private organizational clouds. It can be expanded to be used in e-commerce, storing medical reports, fingerprint, DNA and other essential details of people, providing study materials for education, and so on. Many organizations, including Greenpeace International, claim that cloud computing does more harm than good but we have seen that with proper usage of cloud services a large amount of energy savings and reduction of carbon footprint can be achieved. We have looked into the clouds of Google Inc. and GreenQloud and found them to be quite green as compared to other clouds, like those maintained by Apple or Microsoft. Still, there is huge room for improvement and further research in this field, especially in areas like development of more efficient data servers, cooling systems, and so on.” (Chowdhury, et al, 2013).

“A report from cleantech market intelligence firm Pike Research found that the adoption of cloud computing will lead to a 38% reduction in worldwide data centre energy expenditure by 2020, compared to what would otherwise be used. The Carbon Disclosure Project (CDP) reached a similar conclusion, finding that large US companies that use cloud computing will be able to save \$12.3bn in energy costs and 85.7 million metric tons of CO₂ emissions annually by 2020. The energy savings are equivalent to 200 million barrels of oil enough to power 5.7 million cars for one year. Businesses striving for green IT should look to cloud computing to reduce their emissions and save money, by using cloud computing, businesses can save a lot of money on the amount of power used by computers compared to what it would be with much larger servers. Start-up companies can also save a lot of money on utilities; they may have to be more spent on computer maintenance.” (Vsrdjournals, 2012)

To assess the environmental impact of cloud computing, Microsoft engaged with Accenture a leading technology, consulting and outsourcing company and WSP Environment & Energy a global consultancy dedicated to environmental and sustainability issues to compare the energy use and carbon footprint of Microsoft cloud offerings for businesses with corresponding Microsoft on-premise deployments. To assess the environmental impact of cloud computing, Microsoft engaged with Accenture a leading technology, consulting and outsourcing company and WSP Environment & Energy a global consultancy dedicated to environmental and

sustainability issues to compare the energy use and carbon footprint of Microsoft cloud offerings for businesses with corresponding Microsoft on-premise deployments. The study found that, for large deployments, Microsoft’s cloud solutions can reduce energy use and carbon emissions by more than 30 percent when compared to their corresponding Microsoft business applications installed on-premise. The benefits are even more impressive for small deployments: Energy use and emissions can be reduced by more than 90 percent with a shared cloud service. (WSP, 2010)

Figure : Comparison of Carbon Emissions of Cloud-Based vs. On-Premise Delivery of Three Microsoft Applications

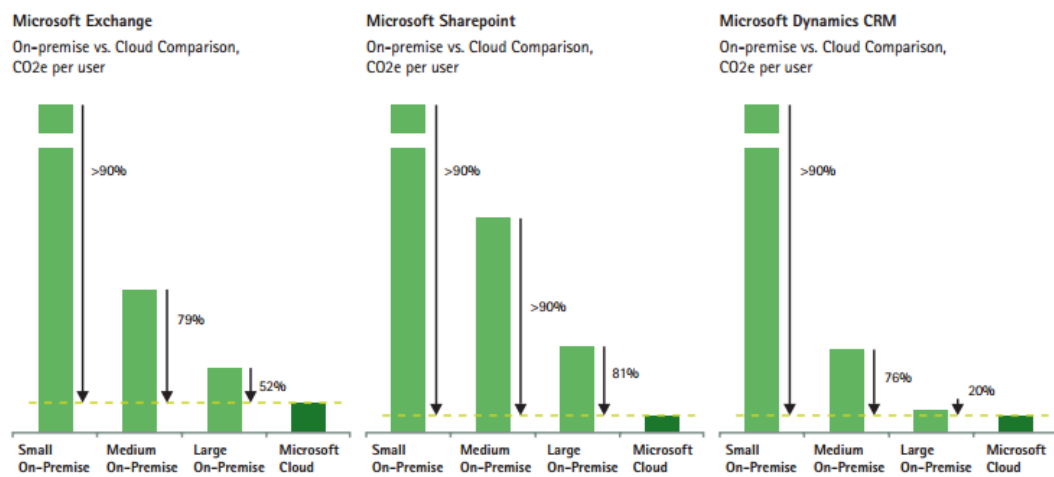


Figure 9: Comparison of Carbon Emissions of Cloud-Based vs. On-Premise Delivery

“Renewable energy resources are abundantly available in Ireland. However, only a fraction of these resources have been tapped so far. They offer sustainable alternatives to our dependency on fossil fuels as well as a means of reducing harmful greenhouse emissions and opportunities to reduce our reliance on imported fuels.” (Sustainable Energy Authority of Ireland, 2013).

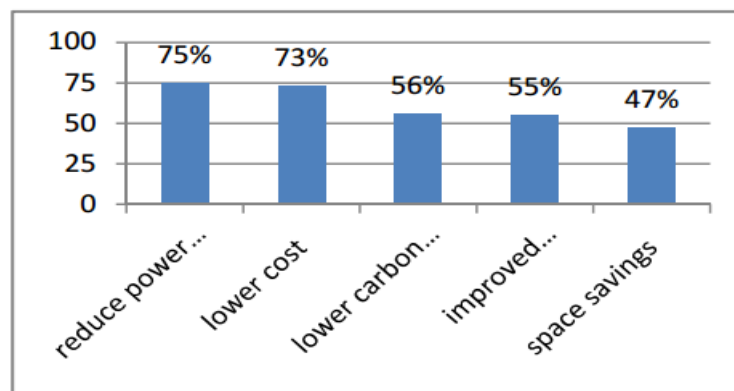
“Each individual's personal commitment to Green Cloud Computing will have an enormous, collective impact. For one thing, the Platform-as-a-Service (PaaS) aspect of cloud computing enables people to develop applications by using cloud-based resources, thereby giving them resources they couldn't have afforded to buy.” (Strukhoff, 2013).

2.6 Conclusion of Literature Review

The literature review section was influential in building the theoretical model that will be used for examining the primary data for concurrences and differences.

“Green Computing has become an innovative way on how technology and ecology converge together. With the recent years many industries and companies have turned their attention in realizing how going 'green' can benefit public relations, reduced costs, and lowering global emissions from industrial manufacturing. Though the term green computing covers a vast range of methods, from energy saving techniques, to the study of materials used in our lives, it all fundamentally breaks down to finding ways to not damage or consume all of earth's natural resources. Ultimately green computing focuses on ways in reducing overall environmental impact, its main purpose is to find and promote new ways of reducing pollution, discovering alternative technologies, and creating more recyclable products.” (Vsrdjournals, 2012)

Figure 10: Reasons and benefits for using Green IT practices



Reasons And Benefits For Using Green IT Practices

Existing literature reviewed related to Green Cloud Computing/Green IT in keeping the following points.

- What is the value of clean energy innovation? Is Green IT a selling point along with other selling point attributes? How much could cheaper clean energy technologies contribute to our economy and energy security?
- How much could Green IT reduce GHG emissions to mitigate global warming?

Compared to hardware-oriented optimization, software systems oriented optimization can be potentially achieved at development stage by setting their power characteristics and adapting the implementation. Both hardware and software solutions need to be highly reliable.

The Government White Paper, Delivering a Sustainable Energy Future for Ireland – The Energy Policy Framework 2007-2020 details policy on the future development of Ireland’s energy system. It addresses the three key policy issues of sustainability, energy security and competitiveness. An overriding disquiet is the challenge of addressing the environmental impacts of energy use, i.e., reducing energy related greenhouse gas emissions in all sectors of the economy. The proportion of fossil fuels in Ireland’s overall energy system is still among the highest in the world. Ireland’s commitments within the EU mean that a 20% reduction in greenhouse gas emissions must be achieved by 2020, primarily by changes in energy provision and use of energy. Vision for the Strategy for Energy Research in Ireland [Irish Energy Research Council, 2008] is; “Ireland meeting its energy system requirements in a manner that addresses the challenges of energy security and environmental sustainability informed, underpinned and facilitated by highly motivated and strongly coordinated teams of energy researchers of world class standard operating in a stable, adequately resourced and continuous research environment”. The strategy recognizes that while urgent action is needed, fostering excellence in energy research and development requires sustained commitment, based on a strong research capability that will also provide a resource for innovation in energy-related products and services. The EU countries including Ireland are committed to global agreements on GHG abatement and there is growing potential to develop smart economy driven, innovative businesses in this area. (UCD, 2014)

More and more research in Green Cloud Computing and genuine care for the environment must come from all the cloud vendors to make this planet clean and green by keeping physical location of Data Centres, through hardware and software.

Literature reviewed in different aspects like how Data centre location can benefit environment (by less emission of GHG), reduce cost, and other ways like virtualization from optimised hardware and software techniques.

Chapter 3 – Methodology

3.1 Introduction

This chapter presents the research methodology that has been chosen to answer the research questions for this study based on the set research objectives. According to Brannick and Roche (1997 p.8), different factors influence the method that a researcher chooses for their study. These include the researcher's belief, the nature of the research problem, the status of scientific research and the theories, if there are any relevant to the problem.

The term methodology refers to the overall approaches & perspectives to the research process as a whole and is concerned with the following main issues:

- **Why** you collected certain data
- **What** data you collected
- **Where** you collected it
- **How** you collected it
- **How** you analysed it (Collis & Hussey, 2003, p.55)

3.2 Research Question(s)

"The research question (sometimes called the problem statement) presents the idea that is to be examined in the study and is the foundation of the research study." (Haber, 2010, p.28)

- How important are Green Environmental issues in Data Centre locations for Cloud Service Providers (CSPs) and Small and Medium Enterprises (SMEs)?

Question Rationale: To understand the view of CSPs and SMEs that Data Centre location can make a difference in Environmental aspects.

- Is Green IT a selling point along with other attributes like price, performance, availability, security, support?

Question Rationale: To understand the factors affecting CSPs and SMEs with Green IT.

3.3 Research Design

"The research design contains the plan for the 'collection, measurement and analysis of data' that will enable the researcher to answer their research questions and meet the research objectives." (Blumberg et al., 2008)

“Your research design is the general plan of how you will go about answering your research questions. It will contain clear objectives derived from your research questions, specify the sources from which you intend to collect data, how you propose to collect and analyse these, discuss ethical issues and the constraints you will inevitably encounter (access to data, time, location and money). Crucially, it should demonstrate that you have thought through the elements of your particular research design.” (Saunders et al, 2012, pp.159-160)

3.3.1 Research Philosophy

Johnson and Clark (2006) cited in Saunders et al (2012, p.128) that the important issue is not so much whether our research should be philosophically informed, but it is how well we are able to reflect upon our philosophical choices and defend them in relation to the alternatives we could have adopted. It is important to go through each of the research philosophies in order to find out which one is the best for the researcher to follow.

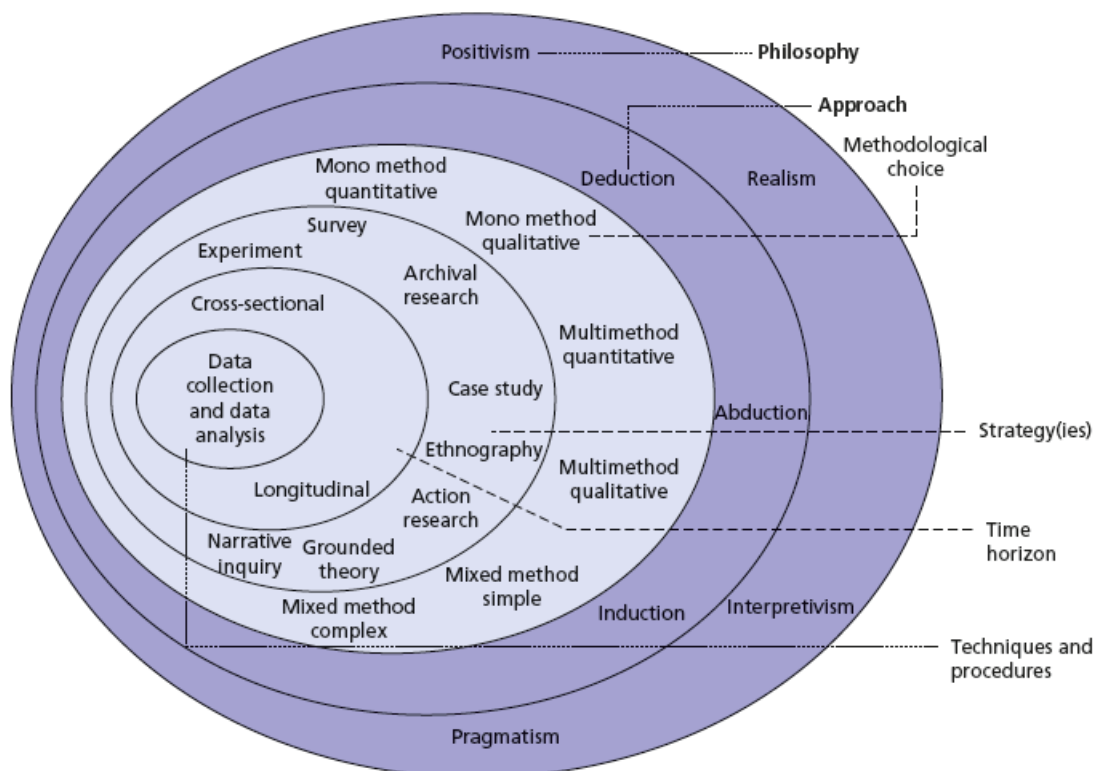


Figure 11: Research Onion - Understanding research philosophies and approaches

“If your research reflects the philosophy of **positivism** then you will probably adopt the philosophical stance of the natural scientist. You will prefer collecting data about an observable reality and search for regularities and causal relationships in your data to create law-like generalisations like those produced by scientists.” (Gill and Johnson 2010 as cited in Saunders et al, 2012, p.134)

Realism relates to scientific enquiry. “That essence of realism is that what we sense is reality: that objects have an existence independent of the human mind. The philosophy of realism is that there is a reality quite independent of the mind.” (Saunders et al, 2012, p.136)

Interpretivism advocates that it is necessary for the researcher to understand differences between humans in our role as social actors. “This emphasises the difference between conducting research among people rather than about objects such as trucks and computers” (Saunders et al, 2012, p.137). Individual cannot be separated from the environment. It is a subjective approach. Reality is socially constructed by the individual.

This **Interpretivism** philosophy suits well to the topic as each individual response on Green IT aspects like whether companies really think about environment when they design, build, locate their Data Centres by Cloud Service Providers, on other hand that does not care about Green IT.

Pragmatism asserts that concepts are only relevant where they support action (Kelman and Rumens 2008). This means that the most important determinant of your position on each of continua is the research question - one position may be more appropriate than another for answering particular questions. The importance of the meaning of an idea (or research finding) is its practical consequences. “Pragmatists recognise that there are many different ways of interpreting the world and undertaking research, that no single point of view can ever give the entire picture and that there may be multiple realities.” (Saunders et al, 2012, p.130)

Comparison of four research philosophies in business and management research

	Pragmatism	Positivism	Realism	Interpretivism
Ontology: the researcher's view of the nature of reality or being	External, multiple, view chosen to best enable answering of research question	External, objective and independent of social actors	Is objective. Exists independently of human thoughts and beliefs or knowledge of their existence (realist), but is interpreted through social conditioning (critical realist)	Socially constructed, subjective, may change, multiple

(Saunders et al, 2012, p.140)

Figure 12: Comparison of research philosophies

3.3.2 Research Objectives

Objectives are more generally acceptable to the research community as evidence of the researcher's clear sense of purpose and direction. "The research needs to be focused and have a clear direction if the research is to be successful. The developing research objectives from the research question to give clear, specific statements of what the researcher wishes to accomplish, will establish the research focus." (Saunders et al, 2012, p.43)

The aim of this research is to investigate that how Data Centre server location is imported to CSPs and SMEs in Green Environmental aspects. Through investigating the processes of successful cloud computing adoption, the researcher will identify the factors that lead to this success. The researcher's interest in the subject area is primarily career enhancement and personal development and the desire to understand the importance of Green IT. The researcher would like to know that Green Cloud Computing initiatives of Cloud Service Providers make an improvement of loyalty from their customers.

3.3.3 Research Approach

There are two approaches that can be taken by the researcher; these are the inductive and deductive approaches (Saunders et al, 2012, p.143). The Deductive approach starts with the development of a research hypothesis, which tests theory, and the design of the research strategy is used to test this

hypothesis. The Inductive approach develops theory from observations and is flexible to take account of the context in which the events are taking place.

Deductive A deductive approach method will be applied to this research for being the most appropriate, it involves the development of a conceptual and theoretical structure prior to its testing through empirical observation (Gill, 2002). The process involves starting out with a theory (Mark, et al., 2009). "Research moves from general ideas/theories to specific particular & situations: the particular is deduced from the general, e.g. broad theories. It is clear that you would want to have a clear theoretical position prior to collection of data. You might therefore research the subject and discover a number of definitions of 'professional' from, for example, a number of professional associations. You could then test this definition on a range of people, using a questionnaire, structured interviews or group discussion. You could carefully select a sample of people on the basis of age, gender, occupation etc. The data gathered could then be collated and the results analysed and presented." (Colin Neville, 2007).

"The deduction approach is the most appropriate when there are comprehensive findings in the literature while the inductive approach is more situations where there are no existing findings in the literature and the researchers works from their findings to build a theory." (Blumberg et al., 2008). The deduction approach suits this research as there has been broad work done on some aspects of Green IT in the literature.

"The prior specification of a theory tends to be disfavoured because of the possibility of introducing a premature closure on the issues to be investigated, as well as the possibility of the theoretical constructs departing excessively from the views of participants in a social setting" (Saunders et al, 2012, p.548).

Main reason to undertake the MBA in Cloud Computing at DBS was to develop a more multi-disciplinary strategy for approaching research questions by enhancing and broadening the areas of application for my research methods and statistical expertise. The researcher will not enforce any preconceived theories or predictions when conducting this research component of the overall

investigation, as this aspect of the overall investigation will follow an inductive process facilitating production of grounded theories derived from the qualitative comments received.

3.3.4 Research Choices

Saunders, Lewis and Thornill (2009 p.141) add that “The choice of research strategy will be guided by your research question(s) and objectives, the extent of existing knowledge, the amount of time and other resource”. This means that the whole components of the study should lead the researcher to the adequate research strategy.

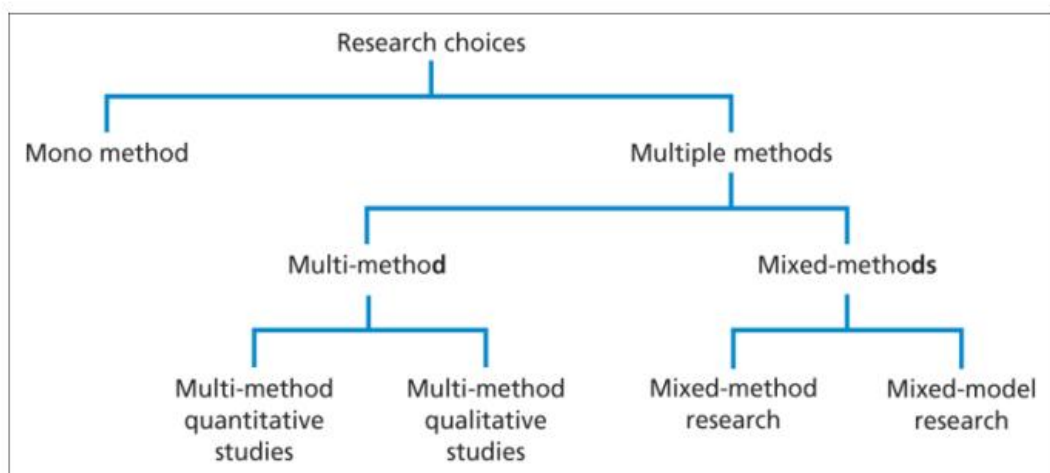


Figure 13: Research Choices

“Even though mixed and multi-methods can be used to increase the reliability and credibility of the findings.” (Blumberg et al., 2008), they are both rejected for this research due to time constraints. “There is also the possibility that by mixing different research methods, the value in each method is diminished” (Sale et al., 2002). For this research, the researcher does not see the need to use two different research approaches as the findings from the qualitative approach are deemed to be enough.

3.3.5 Research Strategy

There exist seven different research strategies. ‘Each strategy can be used for exploratory, descriptive and explanatory research’, Saunders et al, 2009)

Saunders et al (2009 p.141) add that 'The choice of research strategy will be guided by your research question(s) and objectives, the extent of existing knowledge, the amount of time and other resource'. This means that the all components of the study should lead the researcher to the adequate research strategy.

Experiment research is dealing with independent and dependent variable. The aim of this form of research is to make experiments based on variable variations and formulate conclusion from the reaction. It is fundamentally used to analyze groups of people such as argue Saunders et al, (2009, p. 144) 'The experiment strategy is often used only on captive populations such as university students, employees of a particular organization'

The **survey** strategy is usually associated with the deductive approach. It is a popular and common strategy in business and management research and is most frequently used to answer who, what, where, how much and how many questions. Surveys are popular as they allow the collection of a large amount of data from a sizeable population in a highly economical way. (Saunders et al, 2009, p. 144)

Case study: "Robson (2002:178) defines case study as 'a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence", Saunders, Lewis and Thornhill (2009, p. 145-146). The case study strategy also has considerable ability to generate answers to the question 'why?' as well as the 'what?' and 'how?' questions. (Saunders et al, 2009, p. 145-146)

Case study is the strategy that is used in this work. In order to get a strong understanding of the context, the research will be composed by interviews, analysis, and documentaries link with the exploratory research that it will be undertake in this dissertation.

Action Research: Coghlan and Brannick (2005) define the action research as "research in action rather than research about action". This means that this

research is mainly useful for researchers who are belong to the subject and are directly linked to the context and the issue of the study.

Ground Theory: “Theory is developed from data generated by a series of observations. These data lead to the generation of predictions which are then tested in further observations that may confirm, or otherwise, the predictions.” (Saunders et al, 2012, p.149)

Ethnography: The purpose is to describe and explain the social world the research subjects inhabit in the way in which they would describe and explain it. (Saunders et al, 2012, p.149) This strategy is based on observation in order to explain the reason of human behaviour.

Archival Research: Mostly based on archival documentation, the archival research strategy. “It allows research questions which focus upon the past and changes over time to be answered, be they exploratory, descriptive or explanatory.” (Saunders et al, 2009, p.150)

Interviews will be useful to understand what is going on, and to get better idea of the problem. Then, the researcher will have to put together interviews and findings.

It is better to adopt a strategic approach by knowing what information is needed know where the researcher can get this information being aware that information can be both in electronic or printed forms recording all of his bibliographical material consulting with an expert in his research field checking the library for past projects. This proposed research requires a researcher with experience and knowledge of qualitative methods of inquiry. The researcher has the required experience in relation to all of these areas evidenced through his earlier postgraduate (First Class Honours in MCA - Master of Computer Applications) and 14 years of IT industry experience in top IT companies like IBM and Microsoft (client). He was part of technical interview panel in IBM.

3.3.6 Time Horizon

“The time horizon for this survey is cross-sectional. A cross-sectional study is one that studies a particular situation(s) or experience(s) at a specific time.” (Saunders et al., 2009). As this study measures the CSPs and SMEs perceptions on Green IT and Green Zones at a particular point in time, it fits the characteristics of a cross-sectional time horizon. This is usually the time frame suited to most academic researches due to the time constraints on the research projects.

3.3.7 Selecting Respondents

Cloud Service Providers like Microsoft, Amazon, Salesforce, Google, IBM, hp, Oracle, etc., and Small Medium Enterprises (SMEs) who uses or seeks Cloud services. Participants are employees of CSPs who provides information on Green Cloud Computing from Cloud Service Providers perspective as their environmental aspect as one of selling point. Employees of Small and Medium Enterprises, who are using or seeking cloud services, provide information on Green IT perspective.

“The period of time in which the study takes places is described as the Time Horizon. This can either be Cross-sectional, which studies a point in time of a phenomena, or Longitudinal, which studies phenomena over a period of time observing change and development.” (Saunders et al, 2012). A cross-sectional descriptive study design is used in the qualitative component of this research. That is, the self-report qualitative semi-structured interviews are conducted at one time-point only.

3.3.7 Research Ethics

Ethical issues the researcher expects to come across and how might he handle them

1. Will the research process harm participants or those whom information is gathered?
2. Are the findings likely to cause harm to others not involved in the research?

3. Is accepted research practice violated in conducting the research and data analysis, and drawing conclusions?
4. Are community or professional standards of conduct violated? (Kervin, 1992, p. 38)

Frequently, the nature of a project necessitates the student having access to sensitive information about a company's business. The company may require the student to keep such information confidential, and occasionally may ask the student to sign a formal confidentiality agreement.

If the project report contains confidential information the company may ask the University to keep the report confidential. Any such request should be sent in writing to the Projects Co-ordinator. After marking, confidential reports are kept under restricted access for 2 years instead of being placed in the library. If access needs to be restricted for a longer period application must be made again in writing at the end of this time (Saunders et al, 2012, p.237).

3.4 Data Collection Instruments

Primary data: Semi-structured interviews (individuals and groups), group discussion. Personal interviews constituted one of the most important and valuable sources of information.

The interviews are semi-structured, meaning they had "a sequence of themes to be covered, as well as suggested questions ... (with) openness to changes of sequence and forms of questions in order to follow up the answers given and the stories told by the subjects." (Kvale, 96, p.124)

Secondary data: On top of interviews, secondary data also collected in the form of Journal Articles, Websites of Cloud Providers, Websites of Pollution regulatory bodies like <http://www.seai.ie/>, documentation analysis and industry analyst reports (e.g. Gartner). Additionally, surveys that are relevant to the research are also used.

Various online literature sources:

EBSCO – Discovery service - <http://eds.a.ebscohost.com/>

Emerald Management eJournals – Database providing access to over 160 full-text journals and reviews from 300 management journals.

<http://www.emeraldinsight.com/>

European Union - www.europa.eu.int

Library Electronic Sources – eBooks - <http://koha.dbs.ie>, www.dawsonera.com

Mintel Reports – Database containing detailed market research reports on wide range of sectors. www.mintel.co.uk

Quantitative method has following demerits in general

- The researcher's categories that are used might not reflect local constituencies' understandings.
- The researcher's theories that are used might not reflect local constituencies' understandings.
- The researcher might miss out on phenomena occurring because of the focus on theory or hypothesis testing rather than on theory or hypothesis generation (called the confirmation bias)
- Knowledge produced might be too abstract and general for direct application to specific local situations, contexts, and individuals.

The practical issues involved in collecting the data (e.g. access and ethical issues)

The proposed research be conducted using a cross-sectional qualitative design. The respondents will be assured that their responses will be treated anonymously and that they do not have to take part in the research if they wish not to. The anonymous qualitative semi-structured interviews will be conducted through phone, Skype or face to face.

Most ethical issues can be anticipated and dealt with during the design stage of any research project. This should be attempted by planning to conduct the research project in line with the ethical principle of not causing harm and by adapting our research strategy or choice of methods where appropriate. One of the key stages to be considered is the potential for ethical issues to arise is when seeking access.

Implementation issues

As semi-structured qualitative nature of this part of the proposed research investigation, an exploratory research design will be used. The overall strategy is to develop theories out of the comments received from the employees. These grounded theories will be inductively derived, as this will be a speculative process. That is, the researcher will not enforce any preconceived theories or predictions when conducting this research component of the overall investigation.

3.5 Data Analysis Procedures

Qualitative research is more subjective in nature than Quantitative research and involves examining and reflecting on the less tangible aspects of a research subject, e.g. values, attitudes, perceptions. Although this type of research can be easier to start, it can be often difficult to interpret and present the findings; the findings can also be challenged more easily.

This is a study involving different organisations or group of people to look at similarities or differences between them at any one particular time, e.g. a survey of the IT skills of managers in one or a number of organisations at any particular time. "Cross-sectional studies are done when time or resources for more extended research, e.g. longitudinal studies, are limited. It involves a close analysis of a situation at one particular point in time to give a 'snap-shot' result." (Colin Neville, 2007).

The researcher has had to be a good communicator and listener in order to gather information from respondents. In previous research project the researcher has been involved with in the past during my MCA course programme. He also feel he has an added advantage in the current research as he has 14 years of IT industry experience in India and Canada. Evidenced by the researcher previous research collaboration and continued IT project activities he feels he has the qualities of an effective collaborator and researcher.

3.6 Limitations of Methodology

- It is difficult to get contacts in some of the companies due to lack of access to their office premises and conduct interviews due to their busy back to back meetings on most of the days.
- The research is conducted using a cross-sectional qualitative design.
- The respondents are assured that their responses are treated anonymously and that they do not have to take part in the research if they wish not to.
- Interviews can be very time-consuming: setting up, interviewing, transcribing, analysing, feedback, reporting.
- Different interviewers may understand and transcribe interviews in different ways.

Issues to consider

- Can the question be easily understood?
- Is the question biased?
- Is the question necessary to the evaluation?
- Will interviewees be willing to provide the information?
- Is the question applicable to all interviewees?
- Does the question allow interviewees to offer their opinions/expand on basic answers?
- Are follow up questions likely to be required?
- Will it be straightforward to analyse?

Chapter 4 - Data Analysis/Findings

The aim of this chapter is to present and illustrate the **findings** reasonably descriptively without trying too hard to draw general conclusions.

4.1 Interviews presentation

First interview was with a CEO of a company that provides Consulting and System Integration, Project Management, IT Product Sales and Support Services. R1 (Respondent1) has a vast IT experience for more than 22 years ranging from teaching on various IT subjects to Program management. He was with Microsoft India for 14 years and worked as a General Manager in Times Group before he founded his own company.

Second interview was with an IT Infrastructure Program Manager working for a large product, R&D and services Pvt Ltd Company with thousands of employees and the annual turnover is counted in the billions of US dollars. R2 (Respondent2) delivers the IT Infrastructure deployment projects for that company's office locations across India and Asia Pacific and Japan (APJ) region and some countries in Middle East. He has 15+ years of experience in the IT industry.

Third interview was with a Senior IT operations manager. R3 (Respondent3) is working for a medium sized enterprise. She looks after the IT department for Hyderabad location, which is a head office for the company. This company is in dairy, retail chain, agriculture, bakery and renewable energy sectors in five of South Indian states with thousands of employees and revenue turnover is millions of US dollars. They use their web-site to advertise their range of products and special discount offers and as of now there is no online sale.

Fourth interview was with the IT manager. R4 (Respondent4) is working for a medium sized enterprise as a liaison with Salesforce.com. This company is in the Healthcare sector with group of hospitals and a retail chain of pharmacy stores in many states of India with thousands of employees and revenue turnover is millions of US dollars.

4.2 Findings from the data analysis

Interview recordings were transcribed and analysed to identify themes and topics from the data. They were evaluated to see if there are similarities and differences between collected data.

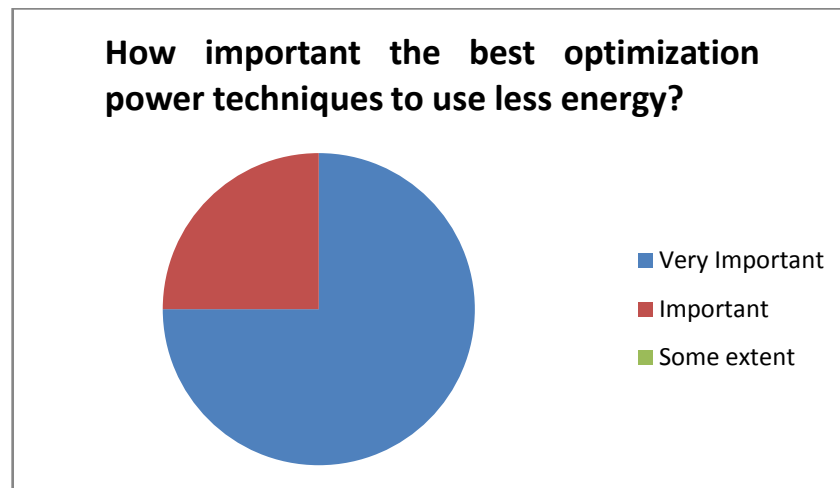
“Once you’ve got all your data, what do you do with them? Remember that they are only data until you have analysed them intelligently. Only then will your data become evidence. So, how do you do the analysis? Your data are likely to come in one of two main forms – words and numbers. What is sometimes called ‘qualitative research’ is research to do with words. When I say ‘words’ I mean words joined up in the way that we usually join them up in language in our everyday lives. I don’t mean isolated words, counted, as you might count them, with questionnaire responses.” (Gary, 2011, pp.69-70)

- **The best practices following for the best optimization power techniques to reduce/use less energy?**

Both experts R1 and R2 strongly recommend the best optimization power techniques start from the design of a Data Centre. Heating, Ventilation and Air Conditioning (HVAC) is very important in building a Data Centre. R1 recommends proper air throw from bottom to top as hot air always rises towards top. Use diffusers to throw hot air out in different directions not just unidirectional. R2 suggests using less lighting with LEDs in Data Centre as much lighting is not required in it as most of the operations can monitor through control systems. Automate all power systems in such a way that it senses it and shuts down whenever it is not in use and wakes up automatically when there is a need. Sensor based automation for not only lighting but also for every piece of equipment in that Data Centre. That is how to optimise power. R3 and R4 also suggest following the best optimisation power techniques to save power and money. R2 commends that waste heat can be used directly or to supply cooling required by the data centre through the use of absorption chillers, reducing chilled water plant energy costs. Heat recovery chillers may also provide an efficient means to recover and reuse heat from data center equipment environments for comfort heating of typical office environments.

Three out of four respondents strongly judge that the best optimisation techniques to reduce power consumption are very important right from the design of Data Centre. Other Respondent also believes it as an important one.

	Very Important	Important	Some extent
Response	3	1	0



- **CSPs strategies behind getting customers to use Cloud services?**

R1 analyses as Small and Medium Enterprises started up to see the advantage of Cloud Computing where the primary reason to believe which will be beneficial for the customers to move to Cloud environment is to help them to reduce footprint on client side and virtualised environment using their private cloud. That's point number one. Point number two, when setting up a company/office and would like to have a Data Centres why not look at host Cloud environment and go to cloud providers who will give the infrastructure at an 'operational expense' rather than capital expenditure as a customer.

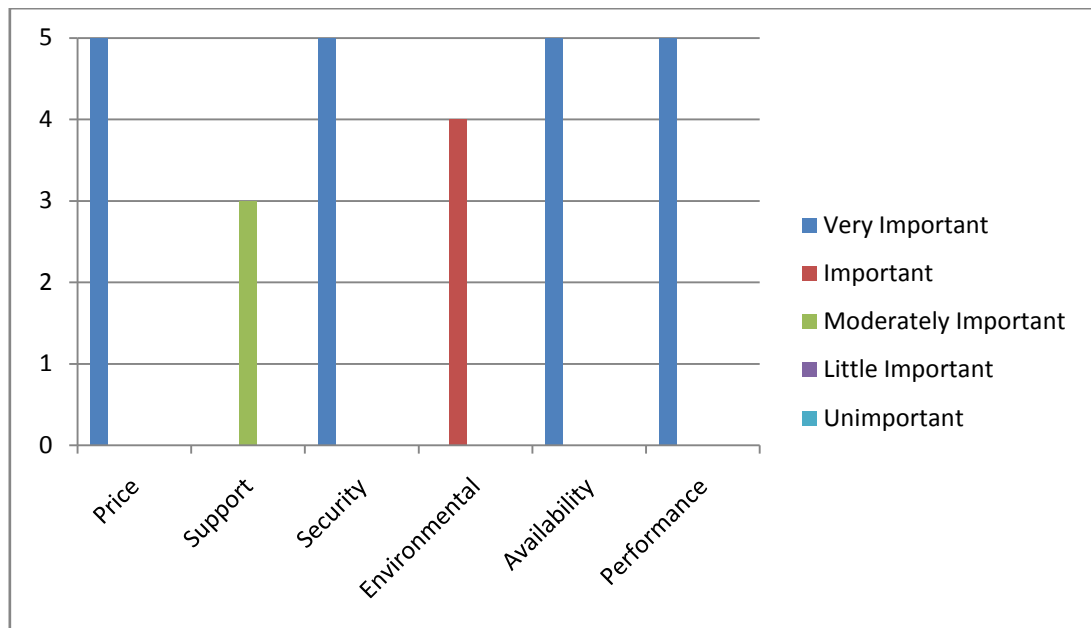
R1 further adds that getting into Cloud Services is very useful rather than setting up the infrastructure and then spending 80% of the time on managing that infrastructure. Leave the managing of the infrastructure and services to the people who are experts in that domain – Cloud. That's how he approaches and tell his customers that how beneficial of Cloud for a company like yours. So reduce Capex, move more towards to operational expenditure Opex which is called in short. That way it saves a lot of time, there is no need to

worry about utilities like power because these Data Centres obviously give an SLA of 99.99% available all the time.

R1 and R2 say that ultimate attributes to consider a Cloud Service Provider are Price, Performance, Security and Availability. R3 and R4 consider the environmental policies of a Cloud Service Provider. Though they consider Price and Security but they are fine with Availability, Performance and Support to some extent from their business requirements.

	Price	Support	Security	Environmental	Availability	Performance
Very Important	5		5		5	5
Important				4		
Moderately Important		3				
Little Important						
Unimportant						

Strategies/attributes behind getting customers to Cloud services

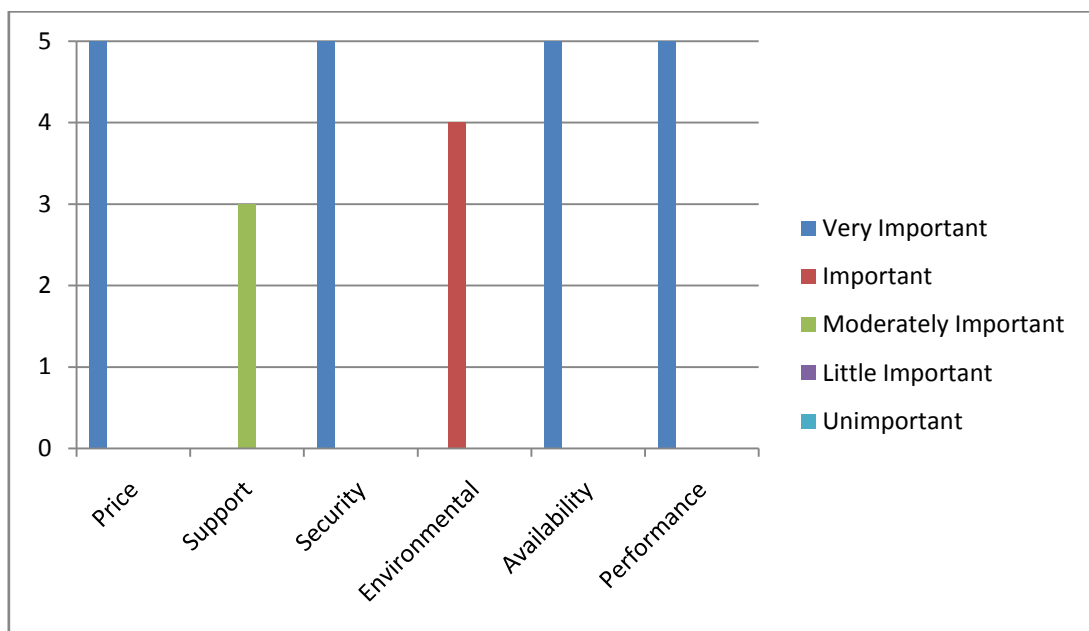


- **Are Small, Medium Enterprises (SMEs) consider their service providers based on least/less price, more security, more availability and performance.**

According to R1 main strategies/attributes are Price, SLAs and Performance for Small and Medium Enterprises to consider their Cloud Service

Providers. For any business it is all about to minimise cost. As per R2, get a Cloud Service Provider benefit in many ways like they can fully concentrate on their business expansion, relieve from power back-up plans, cooling, use less space and less resources. It directly and indirectly saves lot of time on monitoring and controlling. As per R3, primary attributes are Price and SLAs where as availability and performances are secondary as per their business requirements. Their company considers environment to certain extent. According to R3, SLAs are very very important especially for a high profile start up company. If a customer is trying to buy something from your website, if your website is slow, that's a bad experience. Two types of experiences one is performance experience and one is UI (User Interface) experience. UI experience anyway must be taken care of. If performance experience is poor, R1 can guarantee that the customer is never going to come back your website. So, performance where does it come from, it comes from the kind of infrastructure that the CSP gives you.

SMEs perspectives of considering their Cloud Service Providers



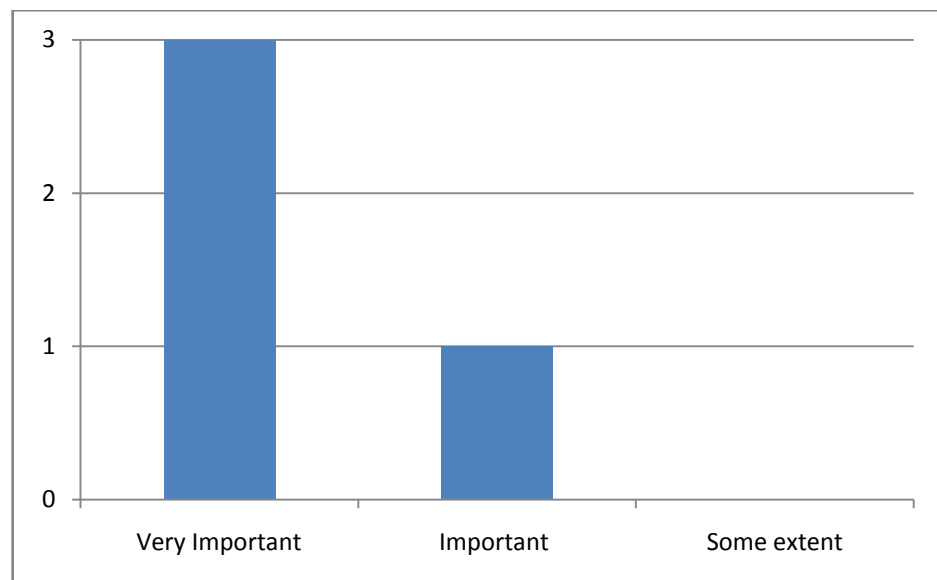
- **How important is the location of Data Centres from the environmental aspect?**

R1 strongly recommends creating Green zones in the world by world's top authority like the United Nations or whoever. Pass a policy resolution, which

says that all Data Centres of all companies should be in either Greenland or Iceland. Just look at the amount of energy which is saved for cooling. Naturally cooled is awesome. The only thing is that, it has its own challenges for cross Atlantic or cross Pacific connectivity, currently that is a big challenge to access those devices and servers located in that space. Nonetheless, though, countries should get together and define some kind of Green Zone, safe planet kind of a zone where all these Data Centres can make best of use of this natural cooling environment. R3 and R4 support siting of Data Centres in Green Zones. Performance is not a constraint for some companies like theirs. Another relevant point they make is, demand of energy is ever increasing so it is necessary to balance this demand with all alternatives. This is an ideal solution from long term perspective as Data Centres continue for a long time. R2 added that natural cool location gives natural cooling at lower energy consumption.

	Very Important	Important	Some extent
Participants	3	1	0

Importance of the location of Data Centres from the environmental aspect



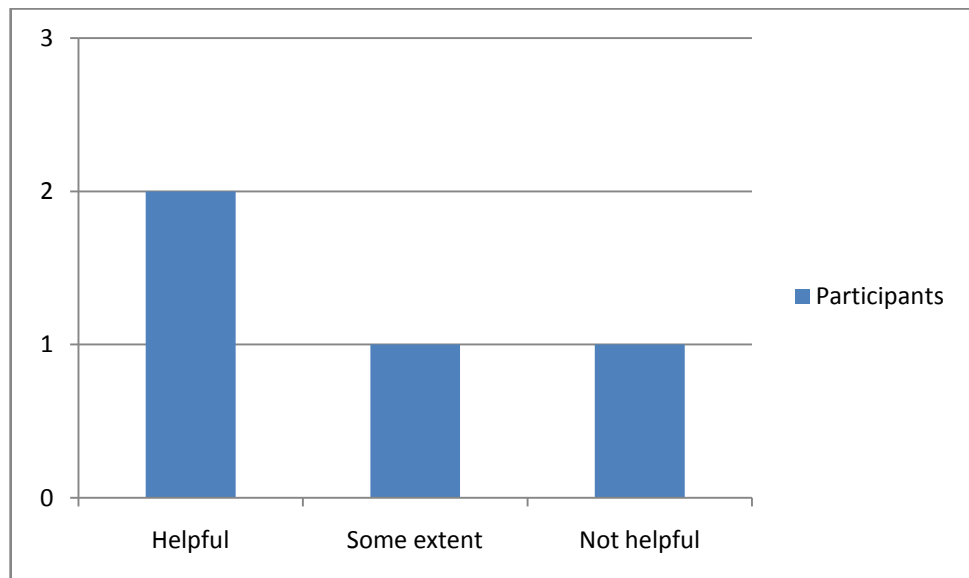
- **Is the environmental aspect of a CSP help as an attribute to consider to getting into a Cloud Service Provider?**

R1 strongly believes that Price is the main factor for any company, not many look into company's environmental policies. Environmental policies of

Cloud Service companies should be made public, how much carbon footprint they are reducing, they have to quote numbers for example the year on year reduction of 10% carbon footprint by doing so many different things. He recommends that Cloud Service Providers can set up their own wind and solar system in their premises to use renewable energy to their Data Centres. R3 and R4 consider Cloud Service Provider environmental policies.

	Helpful	Some extent	Not helpful
Participants	2	1	1

Environmental aspect of a CSP helps as an attribute to consider to getting into a Cloud Service Provider.

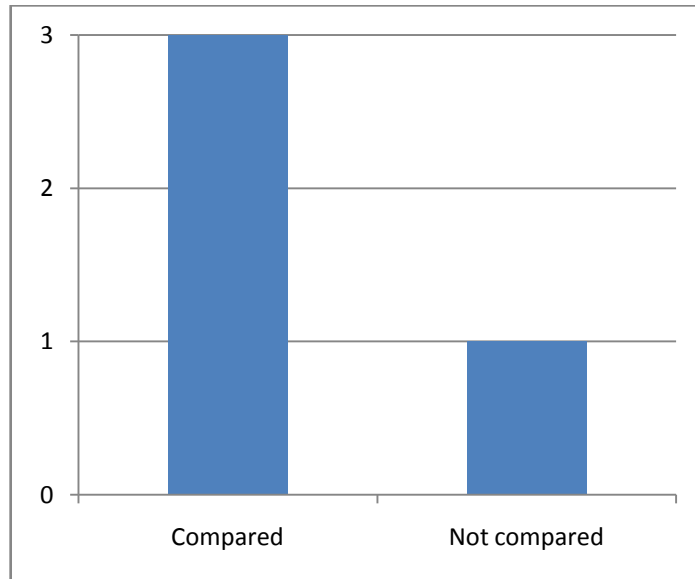


- **Compare Cloud Service Providers based on their environmental policy?**

Both Cloud Service consumer companies' participants R3 and R4 they do consider and compare environmental policies before they get into their CSPs as they are in food and healthcare sectors. R3's company recently entered into the renewable energy business. They promote the use of renewable energy in a greater scale.

	Compared	Not compared
Respondents	3	1

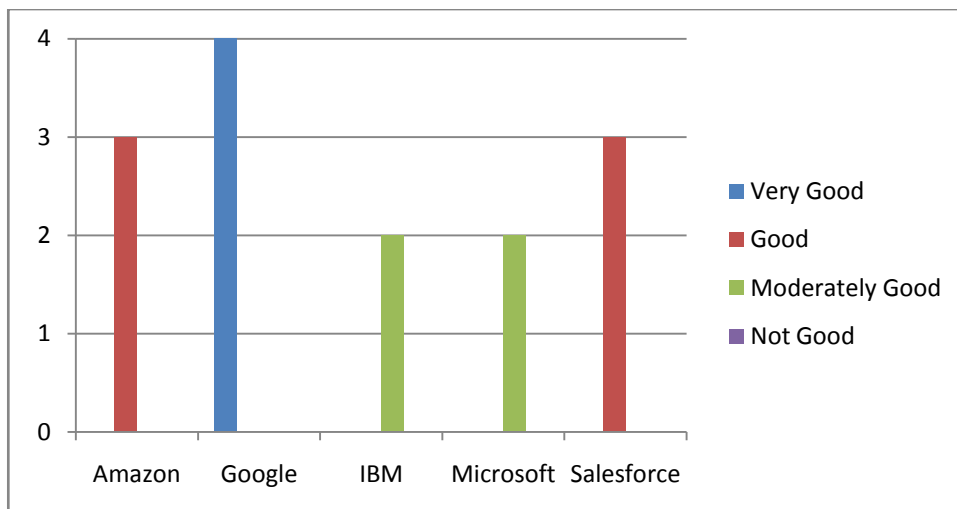
Compared the Cloud Service Providers based on their environmental policy



- **Who is doing good and the best among them (Amazon, Google, Microsoft, IBM, Salesforce, etc.) on the Green IT perspective?**

R1 says that he can't comment directly on any of the company's environmental policy. R3 and R4 found Google is doing good and better than others in environmental aspect.

	Amazon	Google	IBM	Microsoft	Salesforce
Very Good		4			
Good	3				3
Moderately Good			2	2	
Not Good					

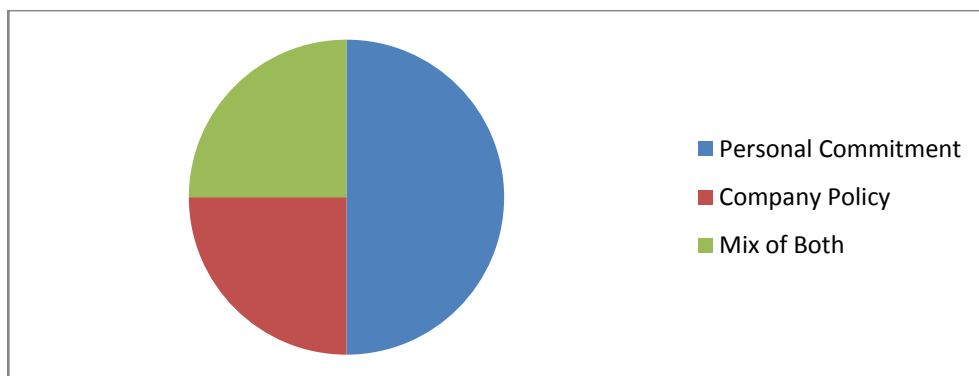


- **Is it executives' personal commitment or company policy to help in Green IT?**

R1 strongly believes it is more of commitment along with company policy. R1 says that strong personal commitment with right policy can work better. If you carry that personal commitment to organisations saying for example, that "I am going to save money for the company by some very nice initiatives whether IT or non-IT. It doesn't matter. So it all starts from within you. Company policy may be there. Who will read 100 pages policy and implement? Instincts come from inside. You want to do something right it has to come from inside. Green IT is something like that. You want to do it because as a company tell the world that I am reducing my carbon footprint as a company. That commitment has to come from inside." (R1) In this world any job any person any individual any company any Government is all because of people. "If people do not have personal commitment towards certain goals in line with organisational goals then it is no use. You can have 1000 page company policy but that won't be any help." (R1)

	Personal Commitment	Company Policy	Mix of Both
Participants	2	1	1

Executives' personal commitment or company policy to help in Green IT



This section presented the findings from the data analysis of the interviews and translated into numbers the quantities to represent graphs using Microsoft Excel. The findings were presented according to the research objectives.

Chapter 5 – Discussion

This study intended to assess the importance of location of Data Centres and Green IT help CSPs as a selling point. This study connects to literature review and the responses from the respondents mainly on setting up a Data Centre in Green Zones. Respondents support Green Zones to reduce the GHG and give a cost benefit to the Cloud consumers. The same is found from the literature review in Lefdal Mine case. They are utilizing a natural old cold mine to set up world's biggest Data Centre with 100% renewable energy. On top of that they are providing ultimate security with extreme physical security (only two single points of entry) and offering natural Electromagnetic Pulse Protection (EMP). Lefdal offers the best price in Europe as they achieved Total Cost of Ownership (TCO) on this project due to the design and the location. Lefdal concept of setting up a Data Centre in a natural cool location meets the idea of Respondent1. But this has to go in a larger scale to benefit the environment and cost to all the CSPs and SMEs.

There many design techniques found from the literature review to build a Data Centre that links to the points shared by R1 and R2. This synchronized to Chauhan and Saxena (2013) finding as there are two issues with respect to cloud IT infrastructure. The first deals with having energy-efficient hardware and computing devices. The second focuses on optimally using hardware to minimize energy resources without compromising performance and security.

Optimize the underlying technologies of the cloud, such as virtualization, Patel (2012) found that virtualization is the first step to adopting the cloud. Services of the Cloud are made available through virtualization and provided on a usage-based pricing model. These resources can be quickly provisioned and easily managed, by the user, without any major inputs from cloud service provider. The cloud pool is a virtualized way of using computer resources. A cloud is useful in various jobs performing approach in which they can include the concept of aggregation and association. Allow workloads to be deployed and scaled-out quickly through the rapid provisioning of virtual machines or physical machines. R1 and R2 believe that virtualization also help in sharing of resource pooling.

Vsrdjournals finds that "Green Computing has become an innovative way on how technology and ecology converge together. With the recent years many industries and companies have turned their attention in realizing how going 'green'

can benefit public relations, reduced costs, and lowering global emissions from industrial manufacturing. Though the term green computing covers a vast range of methods, from energy saving techniques, to the study of materials used in our lives, it all fundamentally breaks down to finding ways to not damage or consume all of earth's natural resources.”

On the view of getting a SME into Cloud Services, R1 and R2 say that ultimate attributes to consider a Cloud Service Provider are Price, Performance, Security and Availability. R3 and R4 consider the environmental policies of a Cloud Service Provider. Though they consider Price and Security but they are fine with Availability, Performance and Support to some extent from their business requirements.

When it comes to initiation and implementation of environmental policies, R1 strongly believes that Price is the main factor for any company, not many look into company's environmental policies. Environmental policies of Cloud Service companies should be made public, how much carbon footprint they are reducing, they have to quote numbers for example the year on year reduction of 10% carbon footprint by doing so many different things. He recommends that Cloud Service Providers can set up their own wind and solar system in their premises to use renewable energy to their Data Centres. R3 and R4 consider Cloud Service Provider environmental policies.

Data Centres get greater benefit when they implement all these techniques to minimise energy consumption and as well as reduce overall operational cost. That way they can maximise their revenues and transfer some benefit to their customers.

Chapter 6 – Recommendations and Conclusions

6.1 Limitations and Recommendations

A limitation of this study is the limited number of participants due to time constraints and the focus group was very small (Cloud Computing is a small section when compared with the whole of IT as a population). So it is recommended that in future research the study is conducted with a larger sample in order to be able to draw more accurate generalisations by improving the confidence level of the findings. This research could also be carried out using the quantitative approach as this will provide a deeper insight from all the participants.

6.2 Conclusions

Conclusion from this study suggests that Data Centres have to follow best environmental design techniques. Cloud Service Providers look for natural cool locations. The idea of Green IT can also be a selling point. Every stakeholder has to commit personally towards a better green environment on this planet. Based on the results of the study, it is evident that the participants (a focus group of people in the Cloud Computing arena) in this study showed a certain level of attention towards Green IT.

The research found that a substantial percent of the respondents highly recommended setting up Green zones for all the Data Centres and following all best practices in setting up a Data Centre without fail. Green IT is a selling point perspective, which the researcher didn't find much in the literature. Participants believe that it could help as an indirect selling point to some extent. The research answers its own questions as Data Centre location is very important. Green IT can help CSPs as an indirect selling point.

Some people don't like to waste water as it is a natural source, we can't create it, ground water levels are getting worse year by year and some people don't waste oil (they travel on public transport though they have a car) to save the environment. The same applicable to energy consumption, some people have started to think, talk and act on global warming to a greater extent.

Overall, the findings are encouraging as they indicate a positive thinking towards a better environmental set up. Use more natural clean/renewable energy. This research concludes by agreeing with previous studies, on location aspects and

the best optimisation energy saving techniques. This study suggests setting up more and more Data Centres in Green zones like the Lefdal mine Data Centre.

We have a choice: We can act now to reduce our carbon emissions, slow the pace of global warming, and pass on a safer, healthier world to our children. Or we can choose to do nothing, continue pumping massive amounts of carbon into an already overloaded atmosphere, and suffer the increasingly costly consequences.

Bibliography

1. Andrews, R. 2004, 'Research Questions' London: Continuum
2. Blumberg, B., Cooper, D. and Schindler, P. (2008) 'Business Research Methods' 2nd Edn. McGraw Hill Higher Education
3. Brannick, T. and Roche, W. (1997) 'Business Research Methods' Oak Tree Press
4. Chauhan, N, & Saxena, A 2013, '*A Green Software Development Life Cycle for Cloud Computing*', IT Professional, 15, 1, pp. 28-34, Computers & Applied Sciences Complete, EBSCOhost, viewed 25 Jun 2014.
5. Center for Sustainable Systems, 2013, 'Green IT', Available at: http://css.snre.umich.edu/css_doc/CSS09-07.pdf Accessed on 16th Jul 2014
6. Chowdhury, C, Chatterjee, A, Sardar, A, Agarwal, S, & Nath, A 2013, '*A Comprehensive study on Cloud Green Computing: To Reduce Carbon Footprints Using Clouds*', International Journal Of Advanced Computer Research, 3, 1, pp. 78-85, Computers & Applied Sciences Complete, EBSCOhost, viewed 22nd Jun 2014.
7. Colin Neville, 2007, Introduction to Research and Research Methods, University of Bradford, School of Management.
8. Collis, J. & Hussey, R. 2003, Business Research: a practical guide for undergraduate and postgraduate students, second edition. Basingstoke: Palgrave Macmillan.
9. Data Center Knowledge, 2009, 'Wild New Design: Data Center in A Silo'. Available at <http://www.greendatacenternews.org/articles/share/42864/> accessed 28th Jul 2014
10. Energy Efficiency & Renewable Energy, 2011 'Best Practices Guide for Energy-Efficient Data Center Design' available at: <http://www1.eere.energy.gov/femp/pdfs/eedatacenterbestpractices.pdf> accessed on 16th Jul 2014
11. Gary Thomas, 2011. Doing Research. Edition. Palgrave Macmillan
12. Greenpeace, 2012, '*How Clean is Your Cloud?*' Available at: <http://www.greenpeace.org/international/en/publications/Campaign-reports/Climate-Reports/How-Clean-is-Your-Cloud/> Accessed on 28th Jun 2014
13. Hart, C. 2005 Doing a Literature Search: A Comprehensive Guide for the Social Sciences London: Sage
14. Hulkury M. N., Doomun M. R., 2012, Cornell University Library, '*Integrated Green Cloud Computing Architecture*', available at: <http://arxiv.org/abs/1212.1284>? Accessed on 15th Jun 2014

15. Kolb, A, & Kolb, D 2005, 'Learning Styles and Learning Spaces: Enhancing Experiential Learning in Higher Education', *Academy Of Management Learning & Education*, 4, 2, pp. 193-212, Business Source Complete, EBSCOhost, viewed 29 Jul 2014.
16. Lango, J 2014, 'Toward Software- Defined SLAs', *Communications Of The ACM*, 57, 1, pp. 54-60, Business Source Complete, EBSCOhost, viewed 21 Jul 2014.
17. Lee Yong, H, & Kim Hwan, S 2014, 'A Study of Savings of Power Consumption and Server Space through Integrated Virtualization of UNIX Servers', *International Journal Of Software Engineering & Its Applications*, 8, 5, pp. 219-229, *Computers & Applied Sciences Complete*, EBSCOhost, viewed 28 Jul 2014.
18. Lefdal Mine, The Norwegian Solution, No date. Available at: <http://www.lefdalmine.com/the-norwegian-solution/> accessed on 21st Jul 2014
19. Liang, H, Jia, Z, Gaochao, X, Yan, D, & Jianfeng, C 2013, '*A Survey on Green Computing Based on Cloud Environment*', *International Journal Of Interactive Mobile Technologies*, 7, 3, pp. 27-33, *Computers & Applied Sciences Complete*, EBSCOhost, viewed 19 Jun 2014.
20. Maylor, H. and Blackmon, K. 2005 *Researching Business and Management*. London: Palgrave
21. Mell P., Grance T., 2011, '*The NIST Definition of Cloud Computing*', available at <http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf> accessed on 20th Jun 2014.
22. National Climatic Data Center (NCDC) 2014, '*Global Analysis*,' available at <http://www.ncdc.noaa.gov/sotc/global/2014/6> accessed on 18 Jun 2014.
23. NCDC2, 2014 National Climatic Data Center, *State of the Climate: Global Analysis for June 2014*, published online July 2014, retrieved on July 15, 2014 from <http://www.ncdc.noaa.gov/sotc/global/2014/6> accessed on 18 Jun 2014.
24. Patel, R 2012, 'Secure and Cost Effective Framework for Cloud Computing Based On optimization and Virtualization', *International Journal Of Advanced Computer Research*, 2, 6, pp. 249-253, *Computers & Applied Sciences Complete*, EBSCOhost, viewed 28 Jul 2014.
25. Sale, J., Lohfeld, L. and Brazil, K., 2002. *Revisiting the Quantitative-Qualitative Debate: Implications for Mixed-Methods Research. Quality and Quantity*
26. *Salesforce.com and the Environment: Reducing Carbon Emissions in the Cloud*. Published in 2011. Available at: http://www.sfdcstatic.com/assets/pdf/misc/WP_WSP_Salesforce_Environment.pdf Accessed on 10th Jun 2014

27. Sharp, J.A., Peters, J. And Howard, K. 2002. The Management of a Student Research Project, 3rd Edn. Aldershot
28. Saunders Mark, Lewis Philip, Thornhill Adrian, 2009. Research Methods for Business Students. 5 Edition. Pearson Custom Publishing
29. Saunders Mark, Lewis Philip, Thornhill Adrian, 2012. Research Methods for Business Students. 6 Edition. Pearson Custom Publishing
30. Strukhoff, R 2013, 'Green Cloud Computing: A Theme for 2013', Computerworld Philippines, 22, 5, p. 54, Business Source Complete, EBSCOhost, viewed 03 Jul 2014.
31. Sustainable Energy Authority of Ireland (seai), 2013, 'Renewables' available at <http://www.seai.ie/Renewables> Accessed on 22nd Jun 2014
32. Triplepundit, 2012, 'Using Your Company's Environmental Awareness as a Selling Point' available at: <http://www.triplepundit.com/2012/08/environmental-awareness-as-a-selling-point/> Accessed on 28th Jun 2014
33. UCD, 2014, available at http://www.ucd.ie/graduatestudies/coursefinder/taughtprogrammes/msc-sustainable_energy_greentech/ Accessed on 10th Jul 2014
34. Vsrjournals, 2012, 'New Form of Green IT: Cloud Computing' available at http://www.vsrjournals.com/CSIT/Issue/2012_03_Mar/Web/7_P_Ashok_Kumar_629_Research_Communication_Mar_2012.pdf Accessed on 02nd Jul 2014
35. WSP, 2010, 'Sustainability and Energy' Available at <http://www.wspgroup.com/en/WSP-USA/What-we-do-USA/Services/All-Services-A-Z/SustainabilityEnergy/> Accessed on 27th Jul 2014

Appendix

Interview transcript of Respondent1 (R1)

Dhar (researcher/interviewer): Hi Vishy, thanks your time and for your participation in my dissertation on Green Cloud Computing. I request you to please introduce yourself.

R1 (interviewee): Yeah. Hi, my name is Viswanath. In short I am called as Vishy. I have about 22+ years of experience in Information Technology space. I have been with Microsoft as Regional IT Program Manager about 14 years and subsequently stepped out and started my own business. Currently I own the company and I am the CEO of a company, Your Literati for all things Digital. The company is mainly into IT Services and IT System Integration and Networking for small, medium and large enterprises. That's my introduction Dhar. With respect to my experience in IT industry as I said 22+ years of experience ranges from being teacher of Computer Science to +12 students in starting of my career to recently completed General Manager for IT, Times of India Group in Delhi. That's my experience.

Dhar: Thank you so much for giving all the details. I am glad to meet a very busy person like you and thanks again for your time. Could you please explain about what are the best practices following for the best optimization power techniques to reduce/use less energy?

R1: That's very good question. How many people really understand on how to optimise the usage of power in these days? How many companies are really put efforts to automate consumption of power such a way then there is a power need to be a requirement the system should automatically sense it and shut it down. Large companies want it to do it because they are okay with investing initially and okay with this investment for over a period of time. We go and talk to small companies, they say, that's fine we will have somebody switch on and off the lights for example or switch on or off the racks which are not in use. That manual thing goes into somebody forgetting not to switch off lights and so on so forth, power consumption obviously is not be minimised. So, I won't say in terms of optimisation techniques. Automation is a key. Sensor based automation for not only lighting but also for every

equipment that you have in your Data Centre. Equipment should be capable of automatically sensing that if it is not doing any process, it should go into idle down, shut down, sleep mode or suspend mode. Wake up when there is a need. That's how you optimise power. If you have a Data Centre or an office space where the location is very windy with few dollars of investments on the roof top to have a wind mill which is not visible outside can actually drive a lot of saving for power to your facilities. Those are some of the techniques I would look at if I propose. In fact one of my customers I proposed them that why not build a completely solar energy based Data Centre. I will be your Subject Matter Expert (SME) even though I am not from an electrical field, I can be your SME to drive the thought leadership and help you get green power for Data Centre. Small companies can also definitely look at this option even though, there is an investment cost but over a period of time they will save a lot of money in the long run. In India, for example, Government gives a lot of subsidies if you plan to put up a solar plant power generation facility. Government gives you 60% subsidy to build that but this awareness among small and medium companies doesn't exist. Because Government is also playing limited as they advertise more, they will have more work. They are only working with those guys who are aware of it and hence it's going soon. So it is a public and private partnership (PPP) that always helps for driving these kinds of scheme things. Government is more responsible for doing this in all and many countries. That's my opinion about.

Dhar: Thank you Vishy for sharing those interesting techniques and as well views on promoting Green IT. What you said is really right in aspect of long term benefit, companies once they set up as this is an ongoing requirement of power, without power they can't run. I move to next question. What are the strategies behind getting customers to Cloud services?

R1: In this country people know all about Cloud, is that cloud which is in the sky gets rain. When we talk about Cloud Computing many people are confused. Even I am surprised large companies also struggling with the concept of Cloud Computing how to best enable their internal computing environment whether they have private cloud, public or hybrid cloud (which is a combination of both private and public) and so on. So the evangelism for Cloud Computing in country is picking up. There are

some SMEs (Subject Matter Experts) in Cloud Computing there are companies which do lot of evangelism around Cloud. But the awareness is not circulating that that fast as supposed other advanced countries. But nonetheless we are picking up. People started up to see the advantage of Cloud Computing where the primary reason I believe which will be beneficial for the customers to move to Cloud environment is to help them to reduce footprint on client side and virtualised environment using their private cloud. That's point number one. Point number two, you are setting up a company/office and you would like to have a Data Centres why not look at hosted Cloud environment and go to cloud providers they give you the infrastructure at an operational expense to you rather than capital expenditure to you as a customer. I can save on Capex, I can make sure that the money saved is spent in more strategically shared with Cloud, get more customers. So I can spend more money towards marketing. That would be very useful rather than setting up the infrastructure and then spending 80% of the time managing that infrastructure. Leave the managing of the infrastructure and services to the people who are experts in that domain – Cloud. That's how I approach and tell my customers that how beneficial of Cloud for a company like yours. So you reduce your Capex, move more towards to operational expenditure Opex which is called in short. That way you save a lot of time, you don't need to worry about utilities like power because these Data Centres obviously give you an SLA of 99.99% available all the time. Those guys (Cloud Service Providers) are experts in that domain, don't worry about power. This power goes into your Data Centre have to have back-up infrastructure like generator set, that's another investment for you, that Data Centre will provide you. It is not invested for not only you but for many other customers.

Cooling - again if you build your own Data Centre, you will spend lot of money in cooling, leave it to the Data Centre guy. So, moving towards Opex is more business beneficial in the long run as opposed to building Capex as you grow your company. That's the approach. Did I answer your question? Let me go back to your question.

R1: To check the other selling points like Price, SLAs, Availability, Security and all. I understood that save money on initial Capex and use that in marketing and get more

customers. This is an interesting point. Question is, whether Small, Medium Enterprises (SMEs) are getting their service providers based on least/less price, more security, more availability and performance.

R1: The very reason that you should go to hosted environment like a Cloud Service Provider. The thing is, the company who is planning to take those services, they should definitely be worried about SLAs. What kind of up time, what kind of availability, security able to evaluate that. If you don't have the expertise to evaluate there are some companies like my company can sit with you, consult with you and give you those inputs (availability, security and SLAs). SLAs are very very important especially if you are a high profile start up company. If your customer is trying to buy something from your website, if your website is slow, that's a bad experience. Two types of experiences one is performance experience and one is UI (User Interface) experience. UI experience anyway you have to take care of it. If performance experience is poor, I can guarantee you that customer never going to come back your website. So, performance where does it comes from, it comes from the kind of infrastructure that your CSP giving you. You have to evaluate all that. It is always good idea to prepare yourself for questionnaire and evaluate CSP and make a selection technically, commercially, go and sign up with a person enough knowledge with your requirements with 100%.

Dhar: Thanks you so much on all these aspects. One more related to this Green IT, is environmental aspect of a CSP help as an attribute to consider to getting into a Cloud Service Provider?

R1: If you ask me, create Green zones in the world where world's top authority like United Nations or whoever. Pass a policy resolution, says that all Data Centres of all companies should in either Greenland or Iceland. Just look at the amount of energy you save for cooling. Naturally cooled is awesome. The other stuff most Data Centres I have seen are not really does not have a precision of heating, ventilation and air-condition (HVAC) environment set-up properly. Air throw is not proper. Some Data Centres I have seen, I am shocked that air throw is from the top. Hot air always rises. To push out hot air to have efficient cooling you got to have bottom throw, which

means you have to have false flooring, also have a proper ventilation system also, should have diffuser. A diffuser is a grill tile on a false floor which throws hot air out in different directions. Sometimes I am shocked to see a diffuser in unidirectional to the air throw which is also not good. These are some of those techniques environmentally within the design itself one should take care to build best possible efficient cooling environment Data Centres.

R1: Thank you for sharing that idea of make a universal policy by UN or somebody (independent organisation) otherwise this like difficult for some countries like USA, they keep their Data Centres in their country only as they (companies) are not allowed to keep Data Centres other than USA because of their Government policy. Customers from other countries are worried about their data, safe or whether data accessed by someone else. That is another concern. If UN or someone keeps this Green policy would great for environment as well as location wise, it helps in performance wise because they may get closer to their countries.

R1: The only thing is that, it has its own challenges for cross Atlantic or cross Pacific connectivity, currently that is a big challenge to access those devices and servers located in that space. Nonetheless, thought, countries should get together and define some kind of Green Zone, safe planet kind of a zone where all these Data Centres can make best of use of this natural cooling environment.

Dhar: I agree with you on uniting nations is more important towards Green IT as temperatures are increasing year on year to a higher level in the world. This is year due to El Nino (a band of sea surface temperatures) effect in India and in many countries caused less rains that led to shortage of food and high inflation. Heat generated by Data Centres also adding up on this. So, we have to find out some common solution along with location and design techniques that you have shared. I would like to go to next question. Does Small and Medium Enterprises (SMEs) consider about environmental policy of their Cloud Service Providers (Amazon, Microsoft, Google, IBM, Salesforce, etc.)?

R1: I specifically can't comment on any of these companies and on their environment policies. To answer this question in a different way, people or

customers probably not bothered about those companies environmental policies. It is all about cost. If I request to get a quotation for a Cloud Services from Google, AWS and Microsoft then these companies know that they are in competition. Customers in India are also very cost conscious. The concept of 'Quality' versus 'Cost' is still not that much prevalent. If I am the lowest bidder then I am sure that I get the Purchase Order. Since I am the lowest bidder I have to cut cost for quality of my services to be able to meet my business expenses and margins to provide that services. Environmental policies of Cloud Service companies should be made public, should be evangelised in the market. These companies meet CEOs, CIOs make them learn about how they deliver their Cloud Services. How much carbon footprint are they reducing, they have to quote numbers like we are year on year reducing 10 % carbon footprint by doing so many different things. If you sign-up with us you will add into that number. People have to evangelise. They don't do it there is no awareness nobody bothers.

Dhar: I totally agree with that from a company's perspective. Any business basic motive is maximising their profit. Yes, they always look for less cost. I go with one or two questions as per time constraint. Is executives' personal commitment or company policy to help in Green IT?

R1: That's very nice question. Charity begins at home. As an individual do you want save money for yourself? That's your personal commitment. If you carry that personal commitment to organisations say that I am going to save money for the company by some very nice initiatives whether IT or non-IT. It doesn't matter. So it all starts from within you. Company policy may be there. Who will read 100 pages policy and implement? Instincts come from inside. You want to do something right it has to come from inside. Green IT is something like that. You want to do it because as a company tell the world that I am reducing my carbon footprint as a company. That commitment has to come from inside. In this world any job any person any individual any company any Government is all because of people. If people do not have personal commitment towards certain goals in line with organisational goals then it is no use. You can have 1000 page company policy but that won't be any help.

Dhar: Thanks for your permission to record this interview. If you have concerns or any other interesting ideas can consult my supervisor. His name is Michael Gleeson. Send you my contacts and his contacts if required. Thanks again for your time. I will contact you if I have anything. Thank you so much.

R1: Sure, thanks a lot Dhar. It's pleasure talking to you. I hope that I have given you some of my ideas and thoughts. I strongly believe thought leadership is the way to start specially this kind of initiatives where you have concerned about environment. You as a company or an individual need to do your best otherwise they are not going to work in the long run as well as larger space. Thank you very much if your supervisor feels like talking to me please has him talk to me. I leave you with my phone number. Thank you.

Sample Interview transcript of Respondent2 (R2)

Dhar (researcher): Hi Jashuva thanks your time and for your participation in my dissertation on Green Cloud Computing, requests you to please introduce yourself?

R2 (interviewee): Hi Dharmendra, good evening. I am working for a large IT product, R&D and services Pvt Ltd., as an IT Infrastructure Program Manager. My role is to drive and deliver the IT Infrastructure deployment projects for Microsoft office locations across India and Asia Pacific and Japan (APJ) region and some countries in Middle East. I have over all 15+ years of experience in IT industry.

Dhar: Thank you, could you please elaborate on Cloud projects and operations going on in your sector?

R2: Throughout my job role, I have deployed many network platforms for various labs, data centres, office locations, offsite locations which had contributed for many new technologies including Cloud production environments and testing environments where IT Research and Development (R&D) is the core job. That is done across these networks.

Dhar: Ok, thanks for sharing all the information. What are the best practices following for the best optimization power techniques?

R2: To consume or use less energy, we do everything whatever we can do, right from the network designing like making network more optimisation in terms of utilising the power. In addition to that you can also implement lot of green solutions like may be go towards LED lighting for your facilities; facility could be your office space or Data Centre space. That is another way of doing it.

Dhar: In general what are the strategies behind getting customers to Cloud services?

R2: First point to SME is to avoid Capital Expenditure (Capex) as hardware depreciates at very rapid speed. If they are not sure on their business for a long term then getting into Cloud Service helps them a lot. They save time and money. Small businesses always struggle with investments, so they look for a better bid from the providers.

Sample Interview transcript of Respondent3 (R3)

Dhar (researcher): Hi Kala, thanks for your time and for your participation in my dissertation on Green Cloud Computing, requests you to please introduce yourself?

R3 (interviewee): This is Kala S and my call name is Kala, I am working for a medium sized enterprise as a Senior IT operations manager, looks after IT department for Hyderabad location, which is our head office of the company. My company is in dairy, retail chain, agriculture, bakery and renewable energy sectors in 5 of South Indian states. We use our web-site to advertise our range of products and special discount offers and as of now there is no online sale.

Dhar: Thanks Kala for all the details. Did you compare the Cloud Service Providers based on their environment policy?

R3: We do consider environmental policies before we get into our CSPs as we are in dairy, food, agriculture and renewable energy sectors. Our company and I personally consider for a better climate. If you see this year very less rains due to El Nino effect and that causes soaring prices of fruits and vegetables. Indirectly it is impacting on our business and margins as people are looking for alternatives and buys fewer quantities.

Dhar: Ok, I move to next question. Which is most important on a scale of 1 to 5 (5 is most important) from your business perspective?

R3:

Price	Security	Environment	SLAs	Availability	Performance
5	5	5	5	4	4

We give high importance to price, security SLAs and Environment. We do consider environment as an important attribute as we are in dairy, food, agriculture and renewable energy industries. We compromise with availability and performance to certain extent as of now we use our web-site to advertise our range of products and special discount offers and as of now there is no online sale.

Sample Interview transcript of Respondent4 (R4)

Dhar (researcher): Hi, thanks for your time and for your participation in my dissertation on Green Cloud Computing, requests you to please introduce yourself?

R4 (interviewee): My name is Venkateswara Rao P and you can call me as Venkat in short. I am working for a medium sized enterprise as an IT manager. I am a liaison between my company and Salesforce.com. My company is in Healthcare sector with group of hospitals and in retail chain of pharmacy stores in many states of India.

Dhar: Thanks Venkat for all the details. Did you compare the Cloud Service Providers based on their environment policy?

R4: I personally concern about environment as I am fond of clean and green environment. Also from our company's perspective as well we do consider environmental policies before we get into our CSPs as we are in healthcare sector.

Dhar: Which is most important on a scale of 1 to 5 (5 is most important) from your business perspective?

R4:

Price	Security	Environment	SLAs	Availability	Performance
5	4	5	5	4	4

We give high importance to price, security SLAs and Environment. We do consider environment as an important attribute as we are in healthcare industry. We compromise with security, availability and performance to certain extent as our online business very limited. Our business is direct sales through our 24 hours retail outlets.

Self reflection on own learning from this dissertation and from MBA degree

This chapter allows you to review your work and interpret your results, to discuss the implications of your findings. A discussion is a commentary, not a reiteration, of your results. Refer back to your research questions and literature review and discuss how your research has contributed to the area. Demonstrate awareness of the limitations of your research; be critically evaluative of your own work. A good discussion is structured, comprehensive and concise. Finally in this part, the researcher's self-reflection about what he learned during this study. He highlights what does the study brought to him.

A learning style relates a learner's pattern of behaviour in approaching a learning experience taking in new information, developing new skills, retaining new information and applying new skills to life situations (Kolb, 1984). The Kolb learning style is described the process in four stages: Concrete experience, reflective observation, abstract conceptualization and active experimentation.

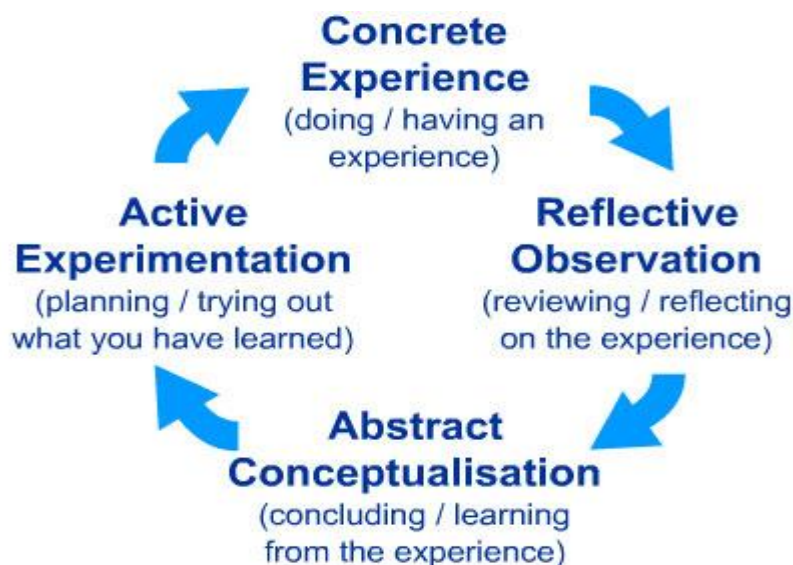


Figure 14: Kolb's Learning Styles

The theory proposes that knowledge develops from the combination of grasping and transforming the experience, through the modes of concrete experience and abstract conceptualization, and then reflective observation and active experimentation (Kolb and Kolb, 2005)

The concrete experience consists in academic and professional knowledge that researcher has acquired prior to MBA program. Researcher has completed his Master's

in Computer Applications, from Andhra University, Andhra Pradesh, India in 1999, and Bachelors in Computer Science in 1996 from the same university. Researcher also did professional certifications related to software testing. His certifications include Microsoft Certified Professional (MCP) in SQL Server, Certified Tester Foundation Level (CTFL) from ISTQB and Certified Software Test Manager (CSTM) from STQC. I worked with IBM for 8 years and also worked for other 2 companies for 6 years. I am also planning to do a Project Management Professional (PMP) certification right after completion of this dissertation to continue my learning interest.

Enrolling on the MBA program was one of the biggest decisions that the researcher has ever taken. When I enrolled for the program, I was new to the country, have no prior contacts, would miss my wife and a small child, leave my job after 14 years of experience and would have to manage finance to support studies and family. I took a step to make my future career bright with an International MBA and that to an emerging technology revolution of Cloud Computing.

The MBA program started in September 2013 with Theory of Cloud Computing, Personal and Professional Development, International Management and Research Methods–1. In the 2nd term which comprised of five subjects, namely, Developing Content for the Cloud, Business Strategy, Financial Analysis, Performance Driven Marketing and Research Methods–2.

This course structure was new and different to me, the methods of assessing academic performance are very different from India. I still managed to understand it quickly. I was able to manage and adopt the new way of academic writing with proper referencing as I attended all library classes. I always used only relevant and reliable sources in references. I avoided blogs, wiki and non-reviewed journals. I always sit on the first bench to get full concentration on classes. I raised questions whenever I need further clarification on the subject and actively participated in interactive conversations in the class and in group case studies. I never missed any class, my class attendance is at 100%. I actively participated in group discussions and group case studies. The Masters program has empowered me with skills that will enable me to become an entrepreneur in near future. The researcher is now confident on stepping up and voicing his opinion about management topics both at work and in personal life. I strongly believe that this

dissertation has been a great exercise for developing new skills, opportunities to meet new people and overcoming limitations. I got new ideas and interesting learnings from all the respondents who are subject matter experts in Cloud arena.

I read several textbooks, journals and previous dissertations which provided a broad introduction and propelled me to consider different perspectives on my thesis. During the writing of this dissertation, the researcher has faced some different experiences which have been turned into a great way of learning. One of the major things the researcher has learned from writing the MBA thesis is that of refining literature review, sequencing the themes in a logical order and how to link primary and secondary data. The researcher is not a native English speaker, therefore writing the dissertation in English has been a huge effort. During the studies of MBA and during the dissertation also included him to work with different individuals. Working as part of a team in group assignments has made him learn to take ownership of the work that needs to be done and contribute to the performance of the team. The researcher has cultured to collaborate with others, as well as negotiate with other individuals to achieve the desired objectives.

The MBA represents the best graduation for someone who desires to build his own company such as it is describe by the MBA guide: “An ideal MBA program helps you in becoming business savvy. The skill-set taught in MBA provides you with the hands-on training for dealing with real work business problems.”

Dublin Business School has provided me with good research tools and resources (books, e-books and wide range of academic journals databases). It has allowed the student to research quality data for each of the assignments during the year. Assignments represented a lot of work, teaching the student how to deal with deadlines and how to manage both time and relationships with colleagues. It gave me an opportunity to learn about others’ strengths and their special skills. It improves my organizational skills and also my communication skills. The experience has been enriched through the interactivity that happened between the students and all the faculty members during the MBA period in Dublin. The overall experience of completion of this full time MBA in Cloud Computing course was rewarding and this experience will provide that my future professional prospects will be praiseworthy.

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Title:	<i>How important are Green Environmental issues in Data Centre locations for Cloud Service Providers (CSPs) and for Small and Medium Enterprises (SMEs)?</i>
Alternative Title:	
Author:	<i>Dharmendra Ungarala</i>
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Subject keywords:	<i>Green Cloud Computing</i>
Awarding Institution:	<i>QQI</i>
Author Affiliation:	<i>School of Business</i>
Qualification Name:	<i>MBA in Cloud Computing</i>
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Date: 20th Aug 2014

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