EnviroInfo 2012: EnviroInfo Dessau 2012, Part 2: Open Data and Industrial Ecological Management

E-Business Applications in a Cloud: an Opportunity for Small and Medium Enterprises to Go Green

Masele, Juma James[1]; Gómez, Jorge Marx[2]

1. Introduction

Sustainability concerns are gaining ground as a better way to do business, because of its contribution to the triple bottom line- economically, environmentally, and socio-culturally (Graci & Dodds, 2008; Taylor, 2008). From this motive, the term Green has evolved in various business sectors with aim to substitute the use of toxic materials with non-toxic materials and non-sustainable practices/processes with more sustainable ones (Ijab et al, 2010). ICT use to transact business (e-business) is also urged to be green. Thus, the term green IT is currently used and is widely acknowledged for both its cost driven strategy, and as a source of opportunity, innovation, and competitive advantage (Porter & Kramer, 2006).

Today, Green IT is considered as a strategic technology that will play a fundamental role in reengineering business and production processes to reduce the environmental footprint of organizations. Murugesan (2008) refers Green IT to environmentally sustainable IT and he defines it as "the study and practice of using computing resources efficiently to minimize environmental impact". Other researchers also prefer the term "Green Information Systems (IS)" (Boudreau et al. 2008; Watson et al, 2010; Harmon and Auseklis (2009) and emphasize that the term Green IS incorporates the concept of Green IT and comprises a greater variety of possible initiatives to support sustainable business processes. A comprehensive overview of current research on Green IT is provided by Molla (2009) who argues that the terms *green, eco-efficiency* and *sustainability* are widely used amongst researchers.Nonetheless, there is a consensus that Green IT is aimed at increasing the energy efficiency of IT operations and enhancing the sustainable usage of material resources, and it includes the environmental dimension of sustainable IS management. In addition, the efficiency enhancements also contribute to the economic sustainability through saving costs. Thus, Green IT represents the intersection of information management with the environmental and economic dimension of corporate sustainability and the process of corporate *greening* (Molla 2009). This study will often use the term Green E-Business, to mean an environmentally friendly (ecological and energy efficient) use of ICT to transact business. Green E-Business thus intends achieving eco-efficiency, eco-effectiveness, eco-legitimacy and eco-profitability use of IT in production, customer focused, and internal management processes of business firms.

As such, many initiatives have been undertaken to make ICT use green in order to address the challenges of increasing power consumption and CO2 emissions. Included in these are virtualization, data centre consolidation, application reduction, data de-duplication, server and PC refresh; mobile computing; power management; print management; redeployment, reuse and recycling; and through cloud computing. However, evidences show that only few enterprises has adopted these methods, and mostly being the large firms, with small and medium enterprises (SMEs) left behind. The situation is even worse in developing countries caused by – size, and their inadequacy in resources (such as funding, skills and personnel); and,

[1] Oldenburg University, Business Information Systems. Sandkakamp 17, 26133 Oldenburg
Abt. Wirtschaftsinformatik I Very Large Business Applications Ammerländer Heerstr. 114-118, 26129 Oldenburg, masele2000@yahoo.com, masele@udsm.ac.tz

[2] University of Oldenburg, Department of Computing Science, Uhlhornsweg 84, D-26129 Oldenburg, Germany. eMail: marx-gomez@wi-ol.de

poor orientation in environmental issues, technology use and regulation, to mention a few (Hoevengel et al, 2007; Buhalis & Main, 1998; Braun, 2002; and, Falkena (2000). In addition to that, the relatively short term focus of most SMEs hinders the adoption of costly long time taking, and risky technologies considering their attitude towards risk and their cost perception with respect to new technologies. This means any support to be done, must be towards the development of ease to use technology that is less risky or whose implementation measures at least partially offset these risks.

Among other mechanisms, possibilities for shared resources including computers and other facilities have been strategies on the table to save investment costs, utilizing less space, avoid risks and, improving efficiency. The invention of Cloud computing technologies is cited by a number of literatures (OECD, 2010; Green peace, 2010; Anand et al, 2010) to be cheap and affordable way to green IT due to its ability to provide shared access to IT resources and common infrastructure, through virtualization offering services on demand over the network to perform operations that meet changing business needs with the location of physical resources and devices being accessed remaining typically not known to the end user.

This paper therefore posits that sharing resources through virtualization and consolidation is one of the possible means that SMEs in developing countries can employ Green E-Business to respond to the three bottom lines. The paper posits the use of Cloud computing- using multiple server computers via a digital network, as though they were one computer (Carey, 2008) such that massively scalable IT-related capabilities are provided "as a service" using Internet technologies to multiple external customers.

2. Problem statement

Although, the use of e-business has from a number of literature been proposed as a way to combat climate change through reduced commuting and use of paper works, where implemented un-green it causes problems too (Siikavirta et al., 2003; Padayachee, 2008; Clausen and Hintemann, 2009). Nonetheless, implementation of Green technologies by Small and Medium Enterprises (SMEs) has always been regarded costly than beneficial considering the heavy investments required against the long payback period it takes (Hoevengel et al, 2007). Moreover, unlike other technology adoptions that promises immediate economic and profitability gains, environmental benefits have been regarded public than private (Bottrill, 2007). This belief slows the adoption pace unless where the burden of adopting is lessened to the adopter. Unless the burden to adoption and use is lessened, SMEs in developing countries will remain environmentally unfriendly when comes to e-business use to compete.

3. Objectives of the study

3.1 General objective

This paper intends to highlight the nexus between virtualization/consolidation possibilities in a cloud and the opportunity that SMEs may venture to enjoy its ubiquitous nature for their informational, operational and strategic advantages while avoiding threats for environment and climate change. The paper brings the attention on the potentiality of cloud computing for SMEs' journey to green e-business. The paper will discuss the strategies behind, supporting features, the opportunities and challenges, and the way forward.

3.2 Specific objectives

- To review the literature on cloud computing techniques, IT virtualization and consolidation and their underlying features
- To establish a link between cloud computing potentials and SMEs' possibilities to use shared IT resources to go green
- To examine the challenges behind use of cloud computing by SMEs
- To recommend on the environment with which cloud computing can be optimally used by SMEs in developing countries to go green

3.3 Significance of the paper

Given the contribution of SMEs to the nations' economy, and particularly in developing countries and the resultant environmental problems caused by these businesses in many parts of the world, the relatively modest adoption of environmental technologies by SMEs becomes crucial. It is being argued that more SMEs adoption to environmental technologies would contribute both to a better environment not only in their countries of locality but also of the whole world for sustainable growth and employment.

4. Literature review

4.1 The Potential of E-Business applications for Minimizing Green House Gases (GHGs) Emission

According to Andam, (2003) e-business is defined as the digital enablement of transactions and processes within a firm including production processes, customer focused process, and internal management processes. Accordingly, firms' e-business applications not only enhance and simplify transaction processes; they also enhance environmental protection through elimination of significant processes that emit GHGs thus warranting sustainability. For example, Masele (2011) proclaimed that, production processes; customers focused processes, and internal management processes can be simply accomplished through e-business hence avoiding tons of CO_2 that could otherwise be emitted through commuting and use of paper works to transact. He (ibid) included activities like building contracts for business, jobs, and tender; conferencing; window-shopping and brochure requirements; inter and intra organization communication; invoicing; and, payments. All these are otherwise paper based without e-business and they involve costs of not only printing and photocopying but also to transport them to final targets. These could otherwise contribute to a lot of greenhouse gases emission. With e-business, the documents could be scanned and online sent through emails or faxes. Payments can be accomplished through credit cards, debits cards, and bank transfer arrangements. It is estimated that 209 million tons of CO_2 could be saved through e-business (The association of European Telecoms Network Operators and the World Wildlife Fund, 2005).E -business thus rests the best means of conducting business without actually commuting (Padayachee, 2008) and or using paper works (Masele, 2011). Business process can be accomplished through intranet, extranet and internet.

However, as it was previously highlighted, where e-business applications are not green, they have a significant responsibility to causing climate change and global warming. Technology analysts estimate that the manufacture, use and disposal of ICT equipment (responsible for e-business) contribute around 2% of global emissions of CO_2 an amount that is equivalent to that caused by aviation sector (Goasduff and Forsling, 2007). It is anticipated that as the use of ICT grows, its emissions are likely to increase to

3% of global emissions by 2020 (Postnote, 2008). However, adoption for green ICT can hardly become a reality unless the adoption process is made easy. A need to thus forge for a cheap and affordable Greening E-Business technology mechanism for SMEs becomes important in order to overcome limitations (financial, time, personnel skills) impending them to withstand pressure to go online. As a result, SMEs have opted to rely on obsolete technologies regardless the consequences they may have to environment.

4.2 The Concept of Virtualization and Consolidation

Possibilities for consolidation and virtualization are growing up in ICT sector, which lead to reduction in hardware costs, improved software testing and deployment, reduced energy and physical space use, and increased flexibility for hardware investments. Thus the consolidation and virtualization processes can be equated to the concept of "economies of scale" through efficiencies (energy and cost wise) gained from shared systems. Ruth (2009), contends that, process virtualization is the main driver of Green IT implementation in organizations, building environmental thinking into their business strategies (Harris, 2008). Well planned consolidation enables organizations to deploy multiple server operating systems such as email, applications, files and others all run on shared server resources. This reduces the number of physical servers that sit underutilized during non- peak periods thus saving energy consumption and requires less physical space, and cost savings for translating into heating and cooling. Virtualization offers a strategy to improve server utilization for both cloud and on-premise scenarios by allowing applications to run in an environment separated from the underlying physical servers. Multiple virtual machines can share a physical server running at high utilization, which reduces the number of physical servers required to meet the same demand. IT organizations can scale individual virtual resources to fit application needs instead of allocating an entire physical system whose full capability is not utilized. In this way, automation of business through virtualization (e.g. online e-commerce) provides a tool for IT departments to narrow the efficiency gap between on-premise deployment and a multi-tenant cloud service, hence saving company's costly resources (personnel, time and space), and the degradation of the environment. As such, it is posited that virtualization is one of the possible means that today's organizations can employ to respond to the requirement for "Reduce, Reuse, Recycle", the global green melody (Velte et al., 2008). Process virtualization includes both the virtualization of the IT infrastructure of an organization as well as the virtualization of its business processes.

4.3 Cloud Computing and It's underneath Features

Cloud computing refers to using multiple server computers via a digital network, as though they were one computer (Carey, 2008). According to Gartner (2008), cloud computing as a style of computing where massively scalable IT-related capabilities (infrastructure, platforms, and software) are provided "as a service" using Internet technologies to multiple external customers. Cloud computing is regarded as a viable option to reduce costs and to improve IT and business agility. Technically, cloud computing works on a client-server basis using web browser protocols where the cloud provides server-based applications and all data services to the user, with output displayed on the client device. The cloud provides a suitable application running on the server which displays work done by the user on the client web browser display. Memory allocated to the client system's web browser is used to make the application data appear on the client system display, but all computations and changes are recorded by the server, and final results including files created or altered are permanently stored on the cloud servers. This can be any file type such word processor, excel etc. Performance of the cloud application is dependent upon the network access, speed and reliability as well as the processing speed of the client device.

There are three services based on the cloud computing concept: Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) and Infrastructure-as-a-Service (IaaS) (Landis and Blacharski, 2010).

In SaaS applications, instead of licensed software being downloaded and installed onto a specific PC, it is paid for as it is used. Yet, this does not preclude customization. Using a common code base for SaaS applications has a big advantage, in that it allows the SaaS provider to continuously refine the program, and push those refinements out to each user on a timely basis. This not only makes for a more robust piece of software, it also allows for the cost to be shared between many users. Some good examples of SaaS according to Lakshmanan, (2009) include: saleforce.com CRM apps; Infosys SaaS offerings-Social platform, ecommerce.

PaaS applications let one to build and deploy web applications on a hosted infrastructure. In other words, PaaS allows the user to leverage the seemingly infinite compute resources (based on the size) of a cloud infrastructure. PaaS can drive down software engineering costs tenfold, reduce time to market, improve profit margins, and lower risks. Nonetheless, PaaS promotes higher levels of security and system interoperability, and can allow system integrators to enter into new markets within days, instead of years. Moreover, PaaS can dramatically lower the skill requirements needed to create new software applications, so that entrepreneurs are empowered to serve their customers, and customers are empowered to serve themselves. In a nutshell, cloud platforms takes cloud computing to the masses.

With IaaS, one can actually buy a "virtual server" over the Internet almost as easy as signing up for an email account (Landis and Blacharski, 2010). The subscriber can simply log on and manage it anywhere and anytime over the Internet in terms of processing time (CPU time), storage, network capacity, and other fundamental computing resources without shelling out big cash upfront. This user only pays for what he/she uses. Cloud infrastructure relies on a shared pool of servers, and any one user can scale up to take advantage of extra computing power when needed. It works because servers are mostly unused anyway, so there's always some extra computing power available if the pool is large enough. Literature (Landis and Blacharski, 2010; Accenture, 2010; Hudaihed, 2010) asserts that infrastructure being elsewhere at a hosted facility, is a strategic advantage to the adopter, due to having somebody else specializing in such things and managing it for you.

All cloud services are accessed on the Internet, with a browser, or with a client application installed locally on the PC, and the application logic, as well as the data, is on the Internet. Since cloud services are web-based, they work on multiple platforms, including Linux, Macintosh, and Windows computers (Singh, 2011; Landis and Blacharski, 2010). A cloud user needs a client device such as smart phones, pads, laptop or desktop computer and other computing devices with a web browser (or other approved access route) to access a cloud system via Internet and World Wide Web access providing cloud services to telecommuting and mobile users (Singh, 2011). Typically the user will log into the cloud at a service provider or private company, such as their employer.

A service provider may pool the processing power of multiple remote computers in a cloud to achieve routine tasks such as backing up of large amounts of data, word processing, or computationally intensive work. These tasks might normally be difficult, time consuming, or expensive for an individual user or operating firm to accomplish, especially with limited computing resources and funds. Computation and storage is divided among the remote computers in order to handle large volumes of both, thus the client need not purchase expensive hardware or software to handle the task. The outcome of the processing task is returned to the client over the network, dependent on the speed of the Internet connection.

4.4 The Potential of Cloud Computing to SMEs

Literature asserts that most consumers (whether they are aware of it or not) are already heavy users of cloud enabled services, including email (*Yahoo, Gmail, Hotmail*), social media, online gaming, and many mobile applications (Accenture, 2010). With increased improvement in technologies Cloud computing innovation offers a great hope to SMEs where they can simply "rent" what they need and somebody else manages the dirty work hence cutting the costs of managing IT to a great extent. Landis and Blacharski (2010) contend that, cloud computing may thus inspire a new wave of entrepreneurship due to its two

main advantages; first, up-front costs tend to be substantially less; and second, it affords a greater level of easy scalability. Due to these fact Cloud computing capacitate anyone (from smallest businesses to largest business enterprises to launch a genuine global business, as it no longer needs start up business to hire a system administrator, or to buy new business software and servers. Emerging entrepreneurs can thus trade everything over the internet, and without the burden of huge up-front capital expenditures. Often, the services available are considered as parts of cloud computing. With cloud computing, even the smallest sized businesses, telecommuters, and independent work-at-home contractors, can do more than collaborate, they can participate. Being ubiquitous, cloud computing makes it easier to do work anytime and from anywhere. One can connect instantly to the office from anywhere in the world, gain secure access to the applications and data, and shortly, get things done in a way that was never possible before.

Evidence by Ladis and Blacharski (2010) assert that reveals that, about 80 percent of IT budget is spent not on the actual purchase of software, but on installing and maintaining it. Yet, disappointing evidence show that most servers operate at only about 15 percent capacity at most times, and over-provisioning is regrettably common. Virtualization, an important element of cloud computing, allows the data center operator to make full use of server capacity. Thus, acompany can do more with less, and with greater efficiency (Landis and Blacharski, 2010). Besides the manpower advantage, companies will also gain an advantage in terms of reduced capital expenditures. This is true because, the cloud not only reduces time spent on administrative duties and development; it also addresses the physical infrastructure itself. SMEs taking full advantage of cloud computing will enjoy a reduced need for servers, storage arrays and the system administration, providing another good source of savings. That, instead of enterprises spending substantial amount of money for purchasing, installing and maintaining software, this amount could be saved and requiring only tenfold of it. Cloud computing thus can be a source of competitive advantages.

4.5 Cloud computing for Efficient and Ecological E-business

Due to importance that sustainability continues to gain as a substantial organization performance indicator (Shanbha, 2011), e-business applications by SMEs obligatorily need to be green in order to satisfy the eco-efficiency, eco-effectiveness, and eco-legitimacy needs. Shanbha (2011) further reveals that cloud computing is able to achieve industry-leading rates of efficiency. He (ibid) simply puts, clouds where better utilized are ecological efficient and less expensive to operate than the traditional data centers.

With Cloud Computing, services may be run on infrastructure platform, so that there is no need for separate physical computers to serve your traffic (Shanbha, 2011). It is the fact that, not all of users use server services at once. Thus, through cloud it allows more users to run servers at high utilization and do the same amount of work on fewer computers, hence saving on the environmental cost of not only building those computers, but also, the cost associated with power consumption (Garg and Buyya, 2011). Nonetheless, when one needs to expand, he won't need to buy the infrastructure and increase CO_2 emissions by way of using more electricity to cool off more computer resources. Instead one can just expand within the cloud using the pre-built resources, halting an increase in electricity usage at his end. Usage of ready-made resources tailored to firm's needs offers beyond the commonly cited benefits of cloud computing such as cost savings and increased agility, it also has the potential to significantly reduce the enterprises electricity expenses whilst reducing CO_2 emissions detrimental to the environment (Garg and Buyya, 2011).

Cloud computing also creates green employees by allowing them to telecommute. This gathers large savings whilst contributing heavily to environmentally friendly green computing. Employees can access the firms cloud from any corner of the world whilst working from home hence avoiding the use of transport and fuel, to and from work, and saving money whilst CO_2 emissions at the same time.

Accenture (2010) summarizes key factors that enable cloud computing to lower energy use and carbon emissions from IT including: (1) Dynamic Provisioning- reducing wasted computing resources through better matching of server capacity with actual demand; (2) Multi-Tenancy-flattening relative peak loads

by serving large numbers of organizations and users on shared infrastructure. (3) Server Utilization- operating servers at higher utilization rates; and, (4) Data Center Efficiency- Utilizing advanced data center infrastructure designs that reduce power loss through improved cooling, power conditioning, etc.

Though large organizations (because of their financial capabilities) can lower energy use and emissions by addressing some of these factors in their own data centers, SMEs are best positioned to enjoy the computing power of cloud computing. SMEs can move applications such as email or collaboration solutions, CRM, Business Intelligence, social media solutions and back office operations on cloud services to take advantage of highly efficient cloud infrastructure, effectively "outsourcing" their IT efficiency investments while helping their companies achieve their sustainability goals. In tourism sector for example, by sharing resources like reservation and property management systems and networks in a cloud, it enables SMTEs to share costs while enabling them to use the system at the same level of applications capacity in terms of infrastructure and features (Cybage Travel and Hospitality Practice Group, 2010). In doing so they save space and energy that would be required when the system was idle.

The analysis by Microsoft, focusing on three of Microsoft's mainstream business applications— Microsoft Exchange®, Microsoft SharePoint® and Microsoft Dynamics® CRM found that for large deployments, cloud solutions could reduce energy use and carbon emissions by more than 30 percent when compared to their corresponding Microsoft business applications installed on-premise. The analysis further revealed that 60 to 90 percent reduction for medium-sized deployments occur, while the benefits were even more impressive with small deployments where they found that energy use and emissions can be reduced by more than 90 percent with a shared cloud service. As the data shows, the per-user energy use and carbon footprint is heavily dependent on the size of the deployment. The cloud advantage is particularly compelling for small deployments, because a dedicated infrastructure for small user counts— as in a small business running its own servers— operates at a very low utilization level and may be idle for a large part of the day. However, even large companies serving thousands of users can derive efficiencies from the cloud beyond those typically found in on-premise IT operation.

Like broadband and other technologies provided by the ICT sector, this review reveals that cloud computing is emerging as a viable, scalable technology that can help significantly reduce carbon emissions by enabling new solutions for smart grids, smart buildings, optimized logistics and dematerialization. It is anticipated that the adoption of cloud computing will lead to a 38% reduction in worldwide data center energy expenditures by 2020, compared to a business as usual (BAU) scenario for data center capacity growth, according to Cloud Computing Energy Efficiency, a new report from Pike Research (2011).

As part of its cloud computing adoption scenario, Pike Research (2011) forecasted that data centers would consume 139.8 terawatt hours (TWh) of electricity in 2020, a reduction of 31% from 201.8 TWh in 2010. This also represents a significant decrease from the 226.4 TWh that would be consumed by data centers in the firm's business-as-usual (BAU) scenario. The reduction will drive total data center energy expenditures down from $23.3 billion in 2010 to $16.0 billion in 2020, as well as causing a 28% reduction in GHG emissions from 2010 levels.

4.6 Challenges towards effective use of Cloud Computing

Although cloud computing puts forwards a number of potentials including management costs reduction and potential for greening IT, it is not itself without challenges. And it isn't to say that cloud computing is perfect. It's not. Being still new, there are thousands of issues at rest to be worked out (Landis and Blacharski, 2009). Looking the technology proactively thus becomes important before a decision to go for is reached. Lakshmanan (2009) categorizes the challenges into technological and business challenges.

Lakshmanan (2009) identified the technological challenges included those related to: security and data confidentiality; availability of services; scalability and performance; availability of after sale support; and, the fact that the technology is still not proven.

According to Lakshmanan (2009), the cloud model still suffers from significant security and data confidentiality related challenge. For example, Software as a Service (SaaS) vendors are implementing disparate security approaches, raising critical questions about where data is hosted, international privacy laws, exposure of data to foreign entities, nonstandard authentication and leaks in multitenant architectures. Others are threats malicious Distributed Denial of Service (DdoS) attacks, Internet worms, hacker threats, and attacks on application vulnerabilities outside the origin data center (Tadwalkar, 2010).These security and data confidentiality concerns are causing reluctance towards the adoption of cloud computing technologies.

Another important issue to think about is related to after sale vendor support. This is important in ensuring availability of necessary trouble-shootings related to the cloud services. Such considerations are argued imperative hence businesses should thoroughly check the viability, performance and integration issues as well as service support capabilities of cloud vendors.

Cloud computing is cited by Lakshmanan (2009) as not yet proven technology. This pulls out confidence that business are developing towards cloud computing. For example, the article by Cloud Security Alliance (2010) on top threats of clouding computing, though Unknown Risk Profile was the only threat that received a consistently lower ranking, it commentary indicated that this is an important issue which makes the future of cloud computing still doubtful. For instance, analysts pointed out that when adopting a cloud service, the features and functionality may be well advertised, but details or compliance of the internal security procedures, configuration hardening, patching, auditing, and logging remain blurred.. Although, virtualization hypervisors mediate access between guest operating systems and the physical computing resources to address this gap, attacks have surfaced in recent years that targeted the shared technology inside cloud computing environments. These attackers focus on how to impact the operations of other cloud customers, and how to gain unauthorized access to data.

This raises a number of questions including: How for instance, are your data and related logs stored and who has access to them? What information if any will the vendor disclose in the event of a security incident? Often such questions are not clearly answered or are overlooked, leaving customers with an unknown risk profile that may include serious threats.

The business challenges include: losing control; vendor lock-in; and, business (service) continuity concerns. There are also concerns of firms losing control over their business. For example Tadwalkar (2009) argued that through open standards like internet makes the cloud customers difficult to exercise control with their cloud vendors. It is suggested therefore that, the enterprise cloud customers would generally integrate their own authentication and access control system with cloud vendors. Tadwalkar (2009) further adds that, it is necessary to make sure that system is under the control of cloud customer. Creating appropriate documentation, measures, and metric and keeping records of all communication with cloud vendors along with issues, challenges faced is extremely important. Accordingly, there could be authentication at cloud vendor level or cloud customer level backed-up by heavy scrutinization.

Vendor lock-in is another challenge. Where the chosen cloud platform API is not open, a client can end up being overly locked into the platform provider for all his/her needs. This is referred to as “proprietary vendor lock-in.” Landis and Blacharski (2009) thus, argued for the importance to make sure that the API is open, allowing for integration with 3rd-party, open source and legacy software and web services.

Business continuity/reliability in the cloud computing environment is another concern (Choo, 2010). This challenge emanates from the fact that cloud computing is an internet based computing, thus any loss of internet connectivity (that could occur in a range of circumstances such as natural disasters) means blockage towards access to their corporate information. There are also concerns related to seizure of a data-hosting server by law enforcement agencies resulting to unnecessary interruption or cessation of unrelated services whose data is stored on the same physical machine. This seizure may result to a lot of unintended consequence of disrupting the continuity of businesses whose data and information were hosted on the seized hardware (Choo, 2010). This raises a lot of concerns about unauthorised access to seized data not related to the warrant, which can result in unintended disclosure of data to unwanted

parties, particularly in authoritarian countries. It is also important to note that positive employee productivity relies on solid and reliable application performance to complete work accurately and quickly. The vice versa is true where scalability and performance are not guaranteed with cloud services providers. Although Cloud infrastructure (IaaS) vendors deliver their services in a scalable way by sharing infrastructure, often, the underlying components that make up this infrastructure, e.g. disk partitions such as CPU caches, GPUs, and other shared elements were not designed to offer strong isolation properties for a multi-tenant architecture (Tadwalkar, 2010).

Other challenges are related to compliance and regulations on cloud computing (Tadwalkar, 2010). Although cloud customers seek services from cloud vendors it is cloud customer's responsibility to ensure that the legal, regulatory and obligations are fulfilled for the applicable IT services of concerned region and country. These laws may include data privacy, financial information control and audit, and credit card payments laws. A challenge is that, these laws vary from country to country, and it to cloud customers to take care. Cloud customers thus are urged to critically examine issues that demonstrate legal and data controls to ensure compliance with published privacy policies and with the privacy and freedom of information regulations in both, their specific countries and at international level. Any kind of official records stored on cloud resources including files, documents, emails, instant messages, memos, forms, scanned images, etc. along with its retention policies should well be looked into to see that they comply with laws, relating to specific countries and at international level.

5. Conclusion and Way Forward

This paper observed cloud computing to have enormous potential to transform the world of IT-reducing costs, improving efficiency and business agility, and contributing to a more sustainable world. The paper viewed that cloud computing could reduce carbon emissions by up to 90 percent for SMEs business applications today and that future energy savings thus sustainable development are likely as cloud computing continues to evolve. Thus, SMEs who adopt cloud computing for their e-business applications will definitely accumulate the inherent business benefits of the cloud, to improve the three bottom lines-economically, socially, and environmentally playing a crucial role in making IT more sustainable by significantly reducing energy consumption. However literature has cautioned that the identified challenges relating to losing control; vendor lock-in; security and data confidentiality; availability/reliability of services; scalability and performance; and, availability of after sale support need to be critically thought before an SME reaches a decision to go on the cloud.

As a way forward, green growth requires strong governments' interventions including provision of important frameworks and infrastructure such as implementable policies, regulations and facilitating conditions to reinforce the behaviors among the SMEs. On top of that, other sustainable development stakeholders including vendors, academicians, enterprises, and related practitioners need to come together with business cases and road maps to re-architect IT infrastructure that can support cloud computing for seamless provisioning and efficient usage of e-business.

Bibliography

Accenture Microsoft Report (2010): Cloud computing and Sustainability: The Environmental Benefits of Moving to the Cloud, http://www.wspenvironmental.com/media.

Anand, Sonal et al (2010): Semantic Cloud for Mobile Technology. International Journal of Computer Applications (0975 – 8887) Volume 8– No.12, October 2010.

Andam, Zarayda Ruth (2003): "E-commerce and E-business". E-Asean Task Force. UNDP-APDIP

Bottrill, C. (2007): “Internet-Based Carbon Tools for Behavior Change,” University of Oxford Environmental Change Institute, Oxford (available online at http://www.eci.ox.ac.uk/research/ energy/downloads/botrill07-calculators.pdf).

Boudreau, M., Watson, R.T. and Chen, A. (2008): From Green IT to Green IS. Cutter Benchmark Review, 8(5), 5-11.

Braun, P. (2002): “Networking Tourism SMEs: E-Commerce and E-marketing Issues in Regional Australia”, *Information Technology & Tourism*, 5(1), 13-24.Moran, 2002.

Buhalis, D., and Main, H., (1998): Information Technology in small and medium hospitality enterprises: Strategic analysis and critical factors, International Journal of Contemporary Hospitality Management, Special Theme Issue: Small hotels: The peripheral tourist sector, Vol.10(5), pp.198-202.

Carey, P.W. (2008): Cloud Computing: The Evolution of Software-as-a-Service. [Online] Available:http://knowledge.wpcarey.asu.edu/article.cfm?articleid=1614. Retrieved 2010-08-22.

Choo, Kim-Kwang Raymond (2010): Cloud computing: Challenges and future directions. Trends & issues in crime and criminal justice pp. 381-400.

Clausen and Fichter, and Hintemann (2009): “How to make computers green? Resources-Efficient Innovations in Schools”

Cloud Security Alliance (2010): Top Threats to Cloud Computing V1.0. Retrieved on 01/09/2011 from http://www.cloudsecurityalliance.org/topthreats/csathreats.v1.0.pdf

Cybage Travel and Hospitality Practice Group, (2010): What is in Cloud for Travel and Hospitality? Cybage Software Pvt. Ltd

Falkena, Hans (2000): SME‘s Access to Finance in South Africa: A Supply-Side Regulatory Review. Internal report

Garg, Saurabh Kumar and Buyya, Rajkumar (2011): Green Cloud computing and Environmental Sustainability

Gartner (2008): Cloud Computing: Defining and Describing an Emerging Phenomenon

Goasduff, L., and Forsling, C. (2007): Gartner Says 50 Percent of Mid and Large Sized Western European ITOrganisations will Develop a Green Strategy by the end of 2008, Gartner, 22 May, 2007, Egham.

Graci, S., & Dodds, R. (2008): Why go green? The business case for environmental commitment in the Canadian hotel industry. Anatolia: An International Journal of Tourism & Hospitality Research, 19(2), 251–270

Green peace International, (2010): Make IT Green: Cloud Computing and its Contribution to Climate Change. Greenpeace International. http://www.greenpeace.org/raw/content/usa/press-center/reports4/make-it-green-cloud-computing.pdf

Harmon, R.R. and Auseklis, N. (2009):. Sustainable IT Services - Assessing the Impact of Green Computing Practices, In Proceedings of the Portland International Center for Management of Engineering and Technology (PICMET), Portland, Oregon.

Harris, J., (2008): Green Computing and Green IT Best Practices on Regulations and Industry Initiatives, Virtualization, Power Management, Materials Recycling and Telecommuting Emereo Pty Ltd., Queensland, Australia.

Hoevenagel, Ruud; Brummelkamp, Guido; Peytcheva, Anna and van der Horst, Rob (2007): Promoting Environmental Technologies in SMEs: Barriers and Measures In: Josefina Lindblom and Luis Delgado (eds) (2007). Sponsored by European Commission and Institute of Prospective Technological Studies (IPTS).

Hudaihed, Ray (2010): Cloud Computing for Small and Medium Businesses (SMBs) Today. Insurance ecosystems.

Ijab, Mohamad Taha et al (2010): Seeking The “Green” in “Green IS”: A Spirit, Practice and Impact Perspective.

Lakshmanan, G (2009): Cloud Computing Relevance to Enterprise. In White Paper (2009) Infosys powered by Intellect Driven by Values.

Landis,C and Blacharski, D. (2010). Cloud Computing Made Easy. Vol. 3. Virtual Global, Inc.

Masele, J.J. (2011): Towards sustainable Tourism: Utilizing E-commerce Applications for Minimizing Impacts of Climate Change. In: Information Technologies in Environmental Engineering: New Trends and Challenges. Springer Vol.3 (pg. 445-460)

Metz C (2009): Bitbucket's Amazon DDoS—what went wrong. The Register 9 October. http://www.theregister.co.uk/2009/10/09/amazon_cloud_bitbucket_ddos_aftermath

Molla, A. (2009): The Reach And Richness Of Green IT: A Principal Component Analysis. In 20th Australasian Conference on Information Systems. Melbourne, pp. 754-764. Available at: http://infotech.monash.edu/about/news/conferences/acis09/Proceedings/pdf/074.pdf.

Murugesan, S. (2008). Harnessing green IT: Principles and practices. IT Professional, 10(1), 24-33.

OECD (2010): Cloud computing for leaner and greener IT infrastructures in governments. Internet Governance Forum 2010, Vilnius, Lithuania, 14-17 September. Workshop No. 106, held by the OECD

Padayachee, Keshnee (2008): Utilizing E-Commerce and M-Commerce Applications to Address the Effect of Global Warming. E-leader, Krakow.

Pike Research (2011): Cloud Computing Energy Efficiency: Strategic and Tactical Assessment of Energy Savings and Carbon Emissions Reduction Opportunities for Data Centers Utilizing SaaS, IaaS, and PaaS

Porter M.E and Kramer M.R. (2006): „Strategy & Society: The Link Between Competitive Advantage and Corporate Social Responsibility‟. Harvard Business Review, 84(12): 78-92.

Postnote (2008): ICT And CO2 Emissions. December 2008 Number 319. retrieved on 28/08/2011 at www.parliament.uk/parliamentary_offices/post/pubs2008.cfm

Ruth, S., 2009. Green IT: more than a three percent solution? IEEE Internet Computing 13 (4), 74–78.

Shanbha, Shilpa (2011): Adoption of cloud computing services enables a company to keep its green commitment in a big way Adoption of cloud computing services enables a company to keep its green commitment in a big way

Siikavirta, H., Punakivi, M., Kärkkäinen, M. and Linnainen, L. (2003): "Effects of e- commerce on greenhouse gas emissions case: home delivery service", Journal of Industrial Ecology, Vol.6, No. 2, pp.83-97

Singh, by Simrandeep (2011): 10 Best Free Cloud Storage Services to Store and Backup Data on the Cloud

Tadwalkar (2010): Cloud Computing –Still a Long Way to Go. A white paper. Mahindra Satyam

Taylor, I. (2008): Sustainability makes good business sense.' Travel Weekly (UK), 12–12.

The association of European Telecoms Network Operators and the World Wildlife Fund, (2005). Savingthe climate @ the speed of light: ICT for CO2 reductions, May 2005

Velte, T., A. Velte, and R. C. Elsenpeter (2008): Green it: Reduce your information system's environmental impact while adding to the bottom line. New York, NY: McGraw-Hill.

Watson, R.T., Boudreau, M.C. and Chen, A.J. (2010): Information Systems and Environmentally Sustainable Development: Energy Informatics and New Directions for the IS Community. MIS Quarterly, 34(1), 22-38.