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New Trends in Business Process Management: Applications of Green Information Technologies

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ABSTRACT

Information Technologies has been playing a great role in keeping the objectives of preserving the environment and one of the techniques is to apply Green computing. Climatic changes have raised the concern worldwide and countries are conducting summits to solve and prevent global warming. Green computing is also called Green Information Technologies (GIT) which is the practice and procedures of using computing and other technological resources in a responsible and environmentally friendly manner. The focus of GIT is to decrease the use of hazardous materials, reduce the usage of energy, increase profit maximization and create awareness of the advantages of recyclability or biodegradability of computer trash. This paper presents the theoretical background of GIT, its roles, and its advantages for preserving climate. Also, this paper presents a qualitative analysis of the advantages and challenges of using GIT in business operations (BPO). These advantages are presented through very short instances and cases for the applications of GIT in BPO. GIT includes new services and products with optimum efficiency andpossible options towards energy saving so it provides the best way to keep the environment clean and healthy without trading off the use of technologies.

1. Introduction

GIT studies the use of computers and other technology in an eco-friendly way for all types of BPO in such a way that the relevance of technologies remains the same and firms achieve profit maximization too. In the current scenario, life without electronic gadgets and devices seems difficult and to an extent impossible (Mrehrour et al,2019). Therefore, it is important to discuss the consequence of using technologies on the environment and explain the advantages of GIT for the future of Earth. In the absence of GIT, an increase in energy consumption would lead to an increase in carbon dioxide and other negative effects on climate. There are several life-saving benefits GIT has which encourage BPO to apply in their practices. Some of the benefits are given in figure 1.

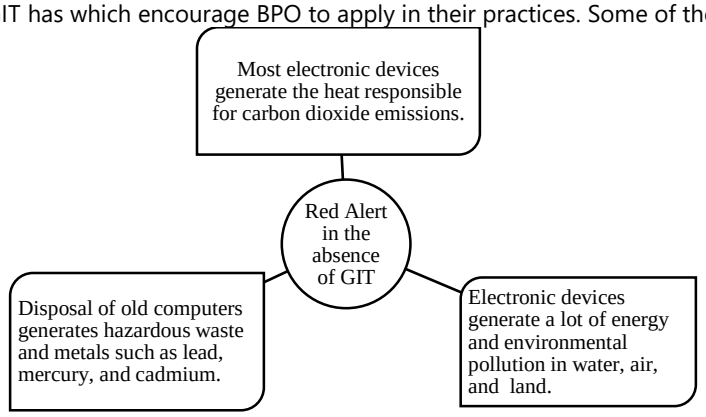

Figure 1. Consequences of not using GIT (Mrehrour et al,2019).

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Firms for their BPO using GIT can reduce the energy consumption of computing and other resources, save energy during idle operation, apply options for eco-friendly sources of energy, reduce harmful effects of computing resources, reduce computing wastes, etc. This approach will help to seek solutions to reduce climatic changes and prevent global warming. This will reduce flood and famine and other natural disasters on the globe. Also, GIT applications can increase the effective use of power and reduce computing wastes. However, the option of GIT is not always cost-effective, firms using GIT for their BPO have to increase their investment but at the stake of climate preservation, this decision is mandatory (Mohapatra et al 2019).

Over the years, IT has fundamentally altered life and improved productivity. IT now has a new role to play to create a greener, more sustainable environment whilst offering economic benefits. But IT has been contributing to environmental problems which most people do not realize. Computers and other IT infrastructure consume significant amounts of electricity, which is increasing day by day, placing a heavy burden on electric grids. Also, IT hardware poses environmental problems during both its production and its disposal. Many people consider IT to be part of the problem of environmental pollution; it can be its savior too. In other words, IT is both a solution and a problem for the environment. We can exploit the power of IT in innovative ways to address mounting environmental issues and make IT systems and their use greener. GIT is the study and practice of designing, manufacturing, and using computers and communications systems efficiently and effectively, with zero or minimal impact on the environment. GIT is where organizations adopt a policy of ensuring that the setup and operations of Information Technology produce a minimal carbon footprint. GIT is also about using IT to support, assist other environmental initiatives, and help create green awareness. Thus, GIT encompasses hardware, software, tools, and practices that improve environmental sustainability. GIT benefits the environment by improving energy efficiency, using less harmful materials, and encouraging reuse and recycling. As businesses and governments try to balance the growth with environmental risks, GIT can help in different ways to improve our environmental sustainability (Mohapatra et al 2019).

This research is divided into three parts. The first part is a Literature Review that will cover the theoretical background of GIT, its generations, and approaches. The second part will discuss in detail the GIT applications, types, challenges, and advantages of GIT in BPO. The third part will show the results of the application of GIT in BPO through short instances.

2. Literature Review

In 1992 by US EPA launched the Energy Star (ES) focusing on GIT. ES was a program installed on computers and other electronic devices to save energy consumption. ES created the sleep mode or standby mode on a computer when it is on but not being used. This program was able to minimize the use of energy and maximize the efficiency of the device (Naim 2021). In the later years, ES enhanced its features and called Green Computing or GIT. With the growth of GIT, many countries joined together to pursue BPO with GIT. Swedish organization TCO launched the TCO Certification program to promote low magnetic and electrical emissions from CRT-based computer displays. It was later expanded to include criteria on energy consumption and the use of hazardous materials in construction. This was the major step of using GIT at the global level (Herath et al 2019)

In 1997, the United Nations' Kyoto Protocol mandated the reduction of carbon emissions and required manufacturers to calculate the electricity used by computers. In 2007 The Climate Savers Computing was created to try to reduce the amount of electric power computer use (Ojo et al 2019).

From past studies we can know, how IT has impacted the environment, it is found that each stage of a computer's life, from its production, through its use and to its disposal, impacts the environment adversely. Since 1997 consumption of IT-based BPO has increased and firms manufacturing computers and their various electronic and non-electronic components consume more electricity, raw materials, chemicals, and water, and eventually generate dangerous wastes harming the environment. All these BPO directly or indirectly increase CO2 emissions and affect the environment. Each computer devices or other electronic inputs generate a ton of CO2 every year and this rate is increasing since 2007. It is found that total electrical energy consumption by servers, computers, monitors, and data communications equipment is increasing every year twice than the previous year resulting in greater CO2 emissions.

Computer components contain toxic materials and consumers discard a large number of old computers, monitors, and other electronic equipment 3–5 years after purchase, and most of this usually ends up in a landfill. Most electronics contain non-biodegradable materials, and heavy metals, and toxic materials like cadmium, lead, and mercury. Over the period of time, these toxic materials have leaked into the ground, where they can contaminate the water people drink, the plants for food, and the animals that live around the area. These toxic materials can cause all kinds of bad effects including nausea, diarrhea, vomiting, and even fatal diseases like cancer.

The increased number of computers and their use, along with their frequent replacements, make IT's the environmental impact a major concern. Consequently, there is increasing pressure onthe IT industry and businesses to make IT environmentally friendly

throughout its life cycle. In the year 2007, climatic changes pushed to implement the GIT for all types of BPO, where GIT referred to as the information technologies and systems, applications, and practices that encompass three dimensions to improving environmental sustainability and preserving nature.

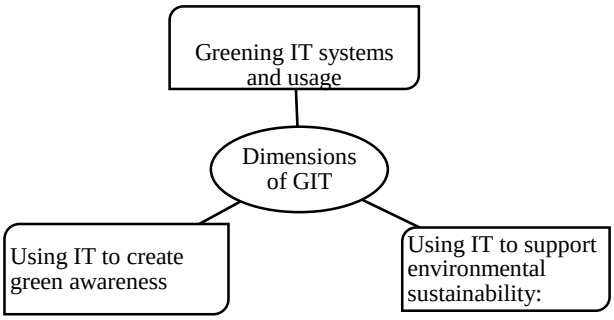

Figure 2. Three dimensions of GIT (Ojo et al 2019)

GIT explains the role and advantages of IT for the environment for various benefits, in the past decade, GIT insists on using efficient and effective design, use, and disposal of computer hardware in an eco-friendly manner, software, and communication systems with no or minimal impact on the environment. Also, GIT encourages the firms to apply the concept not only for a particular BPO but at the enterprise level. Stakeholders and other role players in the business are required to follow the GIT and promote the eco-friendly BPO (Singh et al 2019).

From 2007 to 2009, world submit discussed the role of GIT for higher levels of applications and introduced the generation Green IT 1.0, which explained to reduce the emissions of Greenhouse gases (GHG) by reducing the release of CO2 but only this measure was not enough to prevent climatic changes. Therefore the second generation of GIT 2.0 was introduced in late 2009, GIT 2.0 focused on IT for the green concept. This approach revised the 1.0 application and explained the application of GIT covering all the sectors of businesses. GIT 2.0 was externally focused and empowered the range of other green initiatives aimed at reducing environmental degradation and reducing CO2 emissions. Figure 3 shows the wider benefits and coverage of GIT 2.0

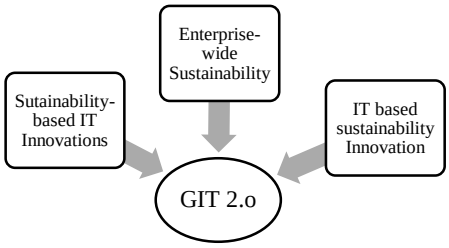

Figure 3. GIT 2.0 Coverage (Naim 2021)

In the year 2010, GIT addressed more options of applications for BPO and suggested six directions for more green advantages. Firms were instructed to apply these options for all the levels of BPO. Figure 4 shows the six directions of GIT that firms can follow for their BPO.

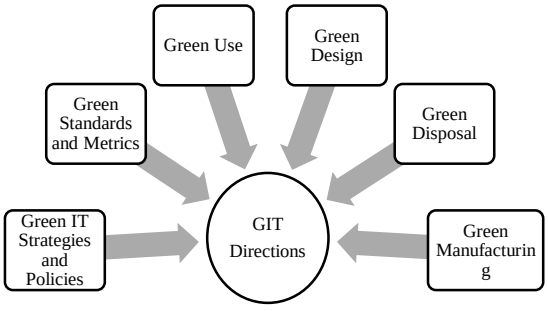

Figure 4. Directions of GIT for BPO (Mihai eta 2019)

These six directions of GIT explained the options and methods for the firms for going green. Some of these methods are designing energy-efficient and environmentally sound components, computers, servers, and cooling equipment, manufacturing electronic components, computers, and other associatedsubsystems with minimal or no impact on the environment. Also, GIT's directions encouraged green use by reducing the energy consumption of computers and other information systems,using them in an eco-friendly manner, disposing of unwanted computers and other hardware in the right manner without causing danger and pollution to land, water and air. GIT suggested the firms apply three Rs in their BPO, which are to reuse, refurbish and recycle. In the year 2015, GIT established benchmarking and strategies to promote more echo-friendly IT techniques for BPO and constantly monitored the firms for their practices, if they are affecting the environment or preserving nature. Figure 5, shows the GIT application for the BPO process and outlines how it can reduce the toxins released into the environment (Naim 2020).

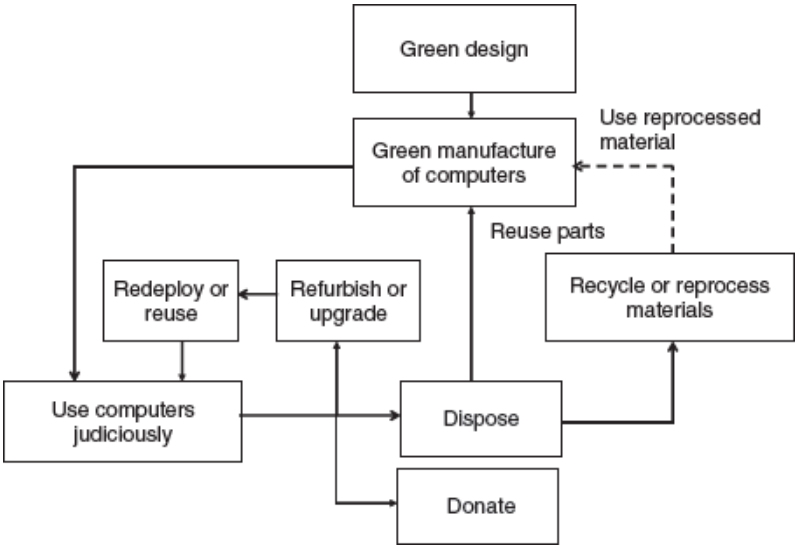

Figure 5. GIT Life-cycle (Naim 2020)

Past sixty years Organization for Economic Co-operation and Development (OECD) produced independent analyses and statistics to promote policies to improve economic and social wellbeing across the globe. (OECD) has proposed a green IT framework consisting of three analytical levels for IT-based firms and for the general business scenario.

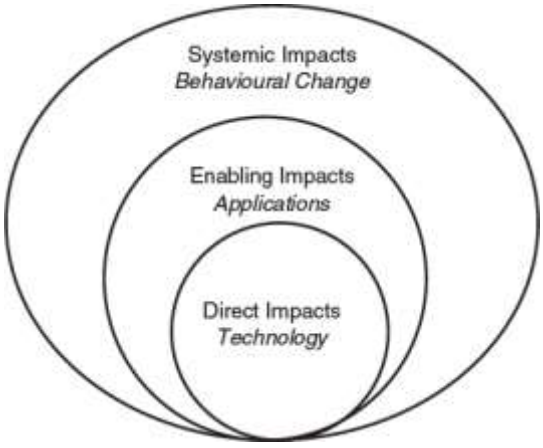

Figure 6. OCED GIT frameworks (Jayalath et al 2019)

3. Discussion

GIT proposes various IT-based solutions to BPO for the successful application and achieving profit maximization as well as contribute to the society for future preservation.

Multithreading (MLT) contributes to GIT for BPO by delivering performance with better energy efficiency (Bindu et al 2019). MLT is the ability of CPU or a single core in a multi-core processor to execute multiple processes or threads concurrently, appropriately supported by the operating system, therefore the application of MLT in GIT facilitates in co

mpleting the workload while consuming less energy. GIT suggests using MLT over single-thread technologies (SNT) because the MLT uses about 25% less energy than the SNT (Naim 2021). A well-balanced MLT workload is more energy-efficient than running the same workload with an SNT. Besides MLT can complete the process one-fourth time faster than SNT and leaves the processor for other processes (Khan et al 2019).

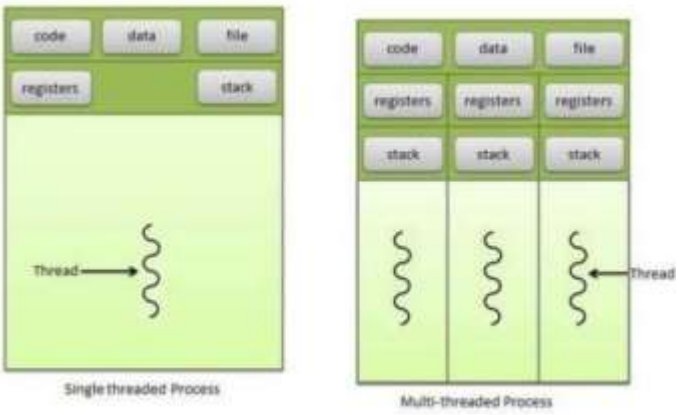

Figure 7. MLT vs. SNT operations (Khan et al 2019)

Another application that GIT encourages the firms to use in its processes is Virtualization (Vn), which is a term used when creating a virtual environment for any program to run on an existing platform as a guest, without interfering or interrupting with the host platform's servicesor programs. The virtual environment running might be an operating system, network,application server among other things. Figure 8 shows the structure of traditional and virtual applications.

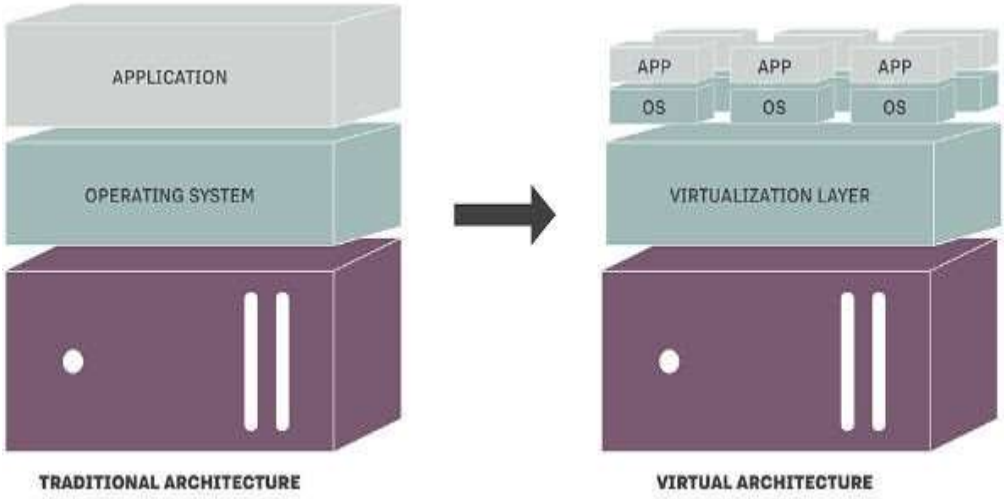

Figure 8. Traditional Architecture and Virtual Architecture (Bothchway et al 2019)

GIT suggests using types of Vn for BPO and for IT-based applications, these are Software Virtualization (S/wVn), Network Virtualization (NVn), and Desktop Virtualization (DVn).

S/wVN involves the creation and operation of multiple virtual environments on the host machine. It creates a computer system complete with hardware that lets the guest operating system run. For example, it lets Android OS run on a host machine natively using a Microsoft Windows OS, utilizing the same hardware as the host machine does. In NVn, there are two or more virtual networks that can be created within the same physical network belonging to the same IP range, and yet they do not have the authorization to communicate with each other (Naim 2019). They operate in their own logical network, with each logicalnetwork having a different set of processes and functions to perform. They are segregated withinthe same physical network. DVN enables to remotely access the data from anywhere and anytime through any device. It provides flexibility and feasibility for employees

and the data is safe and secure as it is stored at a centralized location. All three types of Vn are aiding GIT in using effective and efficient power and energy for completing the processes.

Other technological options that firms can apply for their BPO are Power Management (Pmgnt), Storage Consolidation (StC), Solar Energy Computing (SEC), etc. Pmgnt allows an operating system to directly control the power saving for the hardware devices. This allows a system to automatically turn off components like monitors and hard drives after set periods of inactivity. In addition, a system may hibernate, where most components including the CPU and the system RAM are turned off. Besides some CPUs can automatically under volt the processor depending on the workload, this technology is termed as Speed-step introduced by Intel (Naim 2020). StC offers to allow consolidating data onto a centralized storage system, making the data center more efficient. Direct attached storage, having multiple disk drives in everyserver, results in islands of difficult to manage storage with low utilization levels. Each isolated disk drive consumes power and contributes to the waste stream when the server is ultimately replaced. The centralized storage allows managing storage and servers independently, allowing matching the storage hardware to your data requirements. SEC plays the most critical role in GIT technology, as the use of SEC reduces the emission of heat and other harmful gases such as CO2. In SEC for GIT, cells are used in the large panel and solar cells require very little maintenance after installation. There is no further cost for many years so it is cost-effective also for businesses. Also, SEC devices are manufactured with nonpolluted inputs, and are efficient, silent, and highly reliable. SEC is echoed friendly during the production of this energy no toxic materials or gases are evolved which can harm the atmosphere (Patil et al 2019).

There are many GIT Applications for effective BPO; figure 9 shows the list of some of them.

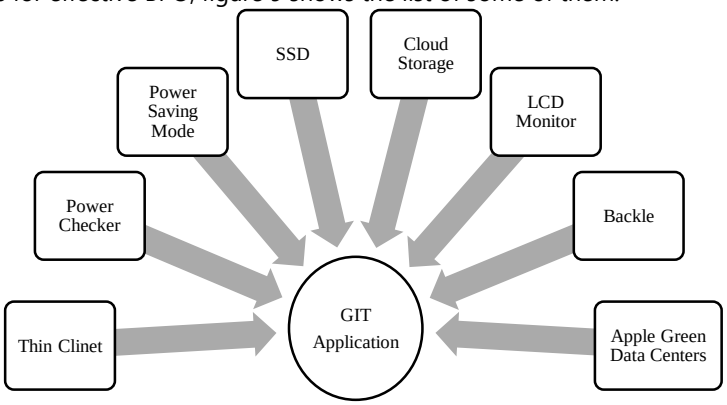

Figure 9. List of GIT Applications (Patil et al 2019).

Cloud storage is a cloud computing model in which data is stored on remote servers accessed from the internet. It is maintained, operated, and managed by a cloud storage service provider on storage servers that are built on Vn techniques. In addition to simply usingless power due to less physical H/w, larger companies (Naim 2019) can reduce their energy consumptionand will also reduce annual carbon emissions to the equivalent of nearly 200 million barrels of oil each year. Some of the green cloud storage services include Google Drive, Mega, and iCloud (Sengupta et al 2019).

Blackle is a search-engine site powered by google custom search which aims to save energy bydisplaying a black background and using grayish-white font color for search results. The results of searches from Google show that if everyone switched from Google to Blackle, 750MW power can be saved each year.

Apple recently announced it has achieved complete reliance on renewable energy sources for all its data centers. Data centers that house computing infrastructure for services like iTunes, Siri, Maps, and the App Store now get 100% of their power from a combination of renewable energy (Sengupta et al 2019).

Most devices and operating systems support many power-saving modes such as screen savers. This mode allows the screen to enter a dormant state after a certain period of inactivity.Sleep mode control causes the screen to turn off after a certain period of inactivity. This mode provides a large amount of power-saving and contributes to echo-friendly aspects. There is also the hard disk sleep mode, but the amount of power provided in this mode is not much. Standby mode stops all computer components after a period of sleep. This mode is characterized by rapid retrieval of the system at reboot, so this is the best method of comfort forthe user and the preservation of the environment, but the amount of energy consumed by the computer in this situation is not as few as 5 watts. The latest situation that the systems currently support is hibernation, which takes an additional step compared to the standby mode, where it loads the memory onto the hard drive and stops all components of the computer. This is the best method in terms of the amount of energy consumed up to 3 watts, but it takes a longer time to reboot, because it needs to load the

memory from the hard disk first, and then restore the system. Operating systems and devices have generally supported different modes to save energy (Sengupta et al 2019).

SSD storage device that uses integrated circuit assemblies as memory to store data persistently. SSD is more energy-efficient than an HDD and replacing hard drives with a solid-state computer can save 10 percent of their energy.
Thin Client is a lightweight computer that doesn't have a hard drive but connects to a server toperform its computing and because it does not have a hard driver, it does not need maintenance, backup, upgrades, or hardware upgrades, and its virtual life is about twice as long as the PC also thin clients use very little energy because most of the processing is done on the server. Thin clients are environmentally friendly because they have less hardware so they generate lesse-waste at the end of their lifecycles. One example of a thin client computer is Sun Ray Thin Client. Sun Ray consumes 4 to 8 wattsof power because most of the heavy computation is performed by a server. Sunrays are particularly well suited for cost-sensitive environments such as call centers, education, healthcare, service providers, and finance (Scionti et al 2019).

LCD monitors typically use a cold-cathode fluorescent bulb to provide light for the display. Some newer displays use an array of light-emitting diodes (LEDs) in place of the fluorescent bulb, which reduces the amount of electricity used by the display. LCD monitors use three times less when active, and ten times less energy when in sleep mode. LCDs are up to 66% more energy-efficient than CRTs, LCDs are also upwards of 80% smaller in size and weight, leading to fuel savings in shipping. LCDs produce less heat, meaningyou'll need less AC to keep cool.LCD screens are also easier on the eyes. Their lower intensity and steady light pattern result in less fatigue versus CRTs (Scionti et al 2019).
The Intel-developed Power Checker tool helped software developers to measure software energy efficiency and write energy-aware software. Energy-aware software shouldbe capable of measuring and reporting dynamically its energy efficiency metrics. The Power Informer tool was designed to simplify this task, so the software vendor can focus on developingthe heuristics required to save energy.

Referring to many case studies on GIT, it was found that if firms use the basic features of GIT in their routine and special BPO, energy can be saved, minimal waste and reduce the emission of CO2 and can bring a good return on investment to the firms also. Table 1 shows some of the features of GIT that have been extensively applied by many businesses in the manufacturing and other operations.

Table 1. Features of GIT for BPO (Scionti et al 2019).

Less use of Dangerous Elements
Energy Efficiency
Recycled Materials Used for Manufacturing
End of Life Recovery
Use of Renewable and Bio-Based Materials
Longer Life
End of Life Take-back Facility
Manufacturer's Certification

A lot of dangerous substances are used in the production of acomputer ranging from the more lethal ones like cadmium, lead, chromium, and mercury to the relatively less dangerous ones like flame retardants, pesticides, and chlorinated plastics (Kabir et al 2019). GIT components should ideally be completely free of these lethal substances, thus IEEE environmental performance criteria require the manufacturers of green computers to explicitly declare the percentage composition of these substances on the product. Energy Efficiency is one of the features of GIT that pleases not only the environmental enthusiasts but also the budget-conscious buyer. Every green computer will have anES rating on it, and the more the stars the more energy-efficient the computer will be. Some green computers are also available with the option of running them on renewable energy like solar energy, for which the manufacturers will supply all the required accessories (Kabir et al 2019). Recycled Materials Used for Manufacturing is a truly green computer that will have most of its components, especially the plastic ones, made of recycled materials. Indeed the manufacturers are required to declare the percentage of recycled material used in the productionof the computer and it should be with minimum thresholds at 10 percent. The GIT is designed in such a way that at the end of their life their components can be easily reused, disassembled, or recycled. A minimum of 65% of the parts of the computer should be recyclable or reusable. Another important GIT feature is the increased use of renewable or bio-based materials. Again a minimum of 10 percent of suchmaterials should have been used in the production of the GIT components, and the same must be declared. GIT comes in modular and upgradeable designs with the idea of extending their life cycle. The manufacturers are required to provide a minimum of 3 years warranty or guarantee, and they must also ensure that the replacement parts will be made available to all buyers up to a minimum of five years

and this is certainly a good reason to buy agreen computer. GIT should come with a take-back policy, wherein the manufacturer provisions to take back the computer at the end of its life and offer the buyer a new purchase at a competitive price. Hence, it is mandatory to verify the brand of GIT in buying or taking back. Before settling on a particular brand of green computers, should ensure that its manufacturer has ISO-14001(Kabir et al 2019), certification, which is the bare minimum for a manufacturer to qualify as environmental-policy compliant. GIT has several advantages and its applications have been made mandatory by the global policies for all the business owners for their BPO. However, it is found that applying GIT is not easy rather a challenging task for all firms for various reasons. Table 2, List some of the challenges of GIT for BPO.

Table 2. List of Challenges for BPO (Kabir et al 2019)

Return of Investment
Disposal of Electronic Wastes
Cost
Design

Return of Investment is the major problem for educating the stakeholders regarding the environmental impact of computers. Also, one drawback with the project is that one cannot demonstrate immediate results. For a BPO that involves Greening, the returns are generally seen after a long period of time. Hence an important challenge in any BPO was to show immediate returns after the successful implementation of GIT. Reliability about the use of GIT in BPO is perhaps the biggest single challenge faced by the industries (Kabir et al 2019). They are likely to be free of hazardous materials such as brominated flame retardants and heavy metals such as lead, cadmium, and mercury, which are common, used in computer manufacturing. Replacements like copper/silver alloy also require higher melting temperatures, which can affect chip life. The use of GIT in BPO always adds extra investments because replacement of present inputs is required and innovative technologies are required for the BPO so that emission of CO2 and wastes can be reduced. Designing with GIT is another challenge faced by the BPO because it has to ensure the design side, energy efficiency in focusing on less power consumption, retaining performance (Naim 2019). This is not a simple process and demands high levels of skilled engineering.

GIT does more for the business dynamic than merely help the environment. While this may be an honorable cause, eco-friendly technology could be used to enhance the workplace. From financial boosts to productivity, firms may find a lot of benefits by adopting a “green” platform. In reality, there are several green products that benefit the workplace outside of protecting the environment. Here are several of the most prolific changes by GIT that could be made in the business that could impact the success (Franca et al 2021)

Reducing Energy Bills is one of the most benefits of GIT at the workplace is reducing the energy bills and operating costs. Small changes such as using LED lighting can save some money in operational costs each month, but more significant changes could greatly reduce spending. Energy efficiency can be implemented in many ways from the insulation of the building to smart windows that offer shade when ultraviolet levels increase. Through eco-friendly technology and affordable additions, the firm could easily reduce the number of your overhead costs (Franca et al 2021)

Reducing Water Use, while water may be cheap in some areas, technology can be utilized to reduce the use of this component in the workplace. Bathrooms, drinking fountains, and gardening are three of the most common uses of water in many businesses. Aerated faucets, efficient toilets, and outdoor timing systems could greatly cut into the monthly water bills. Many companies will install motion-sensing faucets which will automatically turn off when no movement is detected. Some businesses have been able to reduce water waste by more than half because of things like sensor-based appliances.
Less Waste in the Workplace, many organizations pay for the amount of trash that is discarded each month. A lot of these businesses will also pay for paper-shredding services such as insurance companies and those who process confidential information. Moving to a paperless system eliminates a large portion of the waste in the workplace. This has the potential to save money on those services as well as reduce the company's carbon footprint (Okawa et al 2017).

Moving to a Green Web Host, having a website for your business is essential for success. And that means you are going to need a web hosting company. The web hosting industry as a whole has an emissions problem. In fact, it’s become so bad that it eclipses the airline industry in this regard. That’s because data centers for websites consume an incredible amount of power. This consumption equates to more electricity from the grid forcing power plants to produce more energy.
Reducing general office expenses, utilizing more GIT in the business will also reduce general office supply expenses. While paper may be the most obvious product, take into consideration everything else that is related. Spending for pens, paperclips, markers, and more can be reduced by moving into a digital platform (Okawa et al 2017).

Improving Productivity in the Workplace, Many eco-friendly pieces of technology also deliver improvements for productivity. For example, it's much easier to find digital documents on the Cloud than to sift through a filing cabinet.
Mobile devices, messaging systems, and even appliances that improve air quality can make an impact on how people perform their jobs. Some organizations may see improvements by as high as 25% in productivity by moving to an engaging digital platform by the use of GIT.

This increase could lead to additional revenues depending on the types of services the company delivers.
Improving Budgets for Greater Income, moving to a green platform has great potential to save money across the board. These savings can then be utilized in other aspects of the business to generate even more revenue.

For example, the firm can use the money it saves on electricity bills to improve marketing or product enhancements in a store. It may be possible to reinvest that money for other facets that could improve the business even further such as hiring additional staff or investing more in social media (Okawa et al 2017).

Improving Employee Health is one of the most effective benefits in the workplace from eco-friendly technology in the aspect of improving employee health. Air quality, temperate climate, and other factors can lead to staff calling in sick.
This causes a trickle-down effect that makes the business less productive throughout the day. Air purifiers, proper air filtration on HVAC systems, and more can offer a healthier workplace. Even the thought of working in a better environment could improve employee morale, which often leads to greater productivity (Okawa et al 2017).

Improved Disaster Recovery, Green business methods could help the organization recover from even the most devastating of disasters. This is one of the most promising aspects of implementing Cloud-based business services. Important documents, payroll, customer information, and more are all saved online allowing you to immediately get back to work after a catastrophe. Depending on the type of business firms operate, it's theoretically possible to work out of a garage after your establishment has been devastated by a tornado. This alone has the potential to save in hardware expenses, technical support staff wages, and networking maintenance.

Attracting More Customers, there are more people who are conscious about the environment of Earth than you might realize. In fact, 73% of millennials are willing to pay more for sustainable goods and do business with eco-conscious companies. By marketing the company to the general public as "being "green," it could experience a boost in sales and leads. For instance, many hotels have seen a significant influx of customers because they advertised things like solar panels and water-conscious fixtures.

Tax Benefits, depending on the technology you implement, there could be tax benefits for those green devices. For instance, solar panels are still an effective way to receive a tax break worth more than 30% of the total installation cost.
This doesn't include the monthly savings in energy expenses (Naim 2021). However, you'll need to look up your area for local benefits. Some cities offer more of a break than others. In any case, reaching for a green business certificate or ranking may reduce your tax liabilities each year.

Social Responsibility, corporate social responsibility is an aspect that more businesses should keep in mind. As a pillar in the community, you can lead by example when it comes to environmental awareness. Many businesses consume more resources to stay in operation in comparison to private residences. It only makes sense to reduce the amount of waste to maintain the local environment (Okawa et al 2017).

4. Results

This part of the paper shows short examples of successful firms which are world leaders because they have applied GIT in their BPO. They tried to find the solutions for all the challenges and benefitted society by the applications of Green products. Some of the examples are discussed briefly in this paper as results.

1. Intel is known as the world's manufacturer of computer processors. It takes the lead in using green energy of up to 3,100,000,000 k. Intel uses GIT and its green energy is drawn from sources including wind, solar, hydro, and biomass which has 18 on-site solar panels which generate an electricity capacity of 7,000 kW. Intel Company uses the GIT to power its electric operation requirements in the manufacture and processing of processors as well as other computer accessories. The company intends to continue expanding and developing more renewable energy sources so that it can operate on 100% green energy.
2. Apple may not be the largest consumer of green energy but is among the top tech companies utilizing this energy option efficiently. Apple's use of GIT is placed at about 635,000,000 kWh annually. Just like Intel Company, Apple uses green energy to power its electric operation requirements in the manufacture and processing of its technology products

including laptops, monitors, smartphones, and smartwatches. Apple's use of GIT is inspired by the fact that it has the objective of having a neutral carbon footprint. It has acquired numerous solar farms to ensure its data centers are sustainable. Apple also works towards making its entire stores 100% energy efficient by the use of GIT. Apple is very keen on having a good image, whether it comes to its products or how they operate. Therefore, it is unsurprising to see that it is working hard to be as green as it can be. The company states to be the only company that runs its data centers through 100% renewable energy and also has a product range that exceeds the ES guidelines. The company has the goal of powering all of its stores and offices with renewable energy and as of 2013, it had reached 73%, with expectations to reach 100% in the current year.

3. Dell is keen to decrease the energy requirements of its data centers and hardware and has been working to reduce its environmental impact. The company has been one of the leading innovators in the tech sector when it comes to packaging and recycling and in 2014 the company launched its '2020 Legacy of Good' plan. In the plan, the company has set goals to reduce greenhouse gas emissions from its facilities and logistics operations, as well as reduce the energy intensity of its product portfolio by 80%. Dell, one of the leading companies in monitor and laptop manufacturing, also falls on this list because it works towards making the world a better place by using energy from sustainable sources to power its electrical operation needs. The company has heavily invested in solar and wind power to make itself energy sufficient. Besides that, Dell ensures the manufacture of products that are energy sufficient in line with environmental standards. Almost half of the energy used by Dell is from green sources, about 225,000,000 kWh per annum.
4. Google cannot be left behind in the use of green energy on the account that they are one of the biggest advocates for green energy. Since 2007, Google has been carbon neutral and it utilities a total of approximately 735,000,000 kWh of green energy per year. Most of the energy is used to power its data centers as it is more reliable than the traditional power grid systems. Google is also consistently researching novel ways of tapping and utilizing green energy in enhancing sustainability and operational efficiency for industries that are heavily dependent on intensive power use.
5. IBM has been one of the 'green' leaders in tech for a number of years, dating back to 1967 when it issued its first policy on environmental affairs. Big Blue states on its website that they will: "Use development and manufacturing processes that do not adversely affect the environment, including developing and improving operations and technologies to minimize waste, prevent air, water, and other pollution, minimize health and safety risks, and dispose of waste safely and responsibly." The company is very open about its achievements and failings when it comes to its environmental policy, for example detailing its hazardous waste performances.
6. Cisco has been working hard to meet targets on Greenhouse gasses, which it met in 2012, and is now working work to reduce them further. The company has in the past year built 3 solar photovoltaic systems in Texas and Bangalore, which will produce 2 million kilowatt-hours of electricity annually and save over $380,000. They also help to prevent more than 1150 metric tonnes of carbon emissions each year. Cisco Systems is a tech company increasingly exploring the use of green energy to ramp up its operations and support its power demands. It works towards doubling its green energy use by the end of the 2021 fiscal year. Cisco Systems' motive is to prove to the world that green energy plays a critical role in creating a sustainable power use strategy across the entire IT industry. Its primary target is to reduce greenhouse gas emissions and embrace a greener business outlook. Cisco has built into its products, solutions which aim to reduce energy use such as EnergyWise and JouleX, which reduce energy consumption in commercial and residential buildings. Cisco can also boast that 100% of its key manufacturing and logistics suppliers report their Greenhouse gas emissions to the Carbon Disclosure Project.
7. Adobe has long had a green outlook, whether it's focusing on energy conservation, green buildings, or waste reduction.
8. The company was one of the founding members of the U.S. Green Building Council's, 'Building Health Initiative,' and has also invested in renewable energy technologies such as Windspire wind turbines and Bloom Energy fuel cells, which powers several of its California facilities.
9. Microsoft qualifies as the greenest technology company in the world. This is an attribute given to Microsoft's cooperation because it utilizes more than 1.3 billion kWh of green energy on an annual basis. Microsoft works day in and out to ascertain its electric power requirements are supported by green energy.
10. Microsoft is also sufficiently carbon neutral as green energy is sourced from solar and wind power with the most sustainable mechanisms. Green energy is used to power Microsoft's data centers, software development facilities, and product manufacturing.
11. Sprint's commitment to reduce greenhouse gas emissions by 20% is the reason it has embraced the use of green power. The plan has made Sprint indulge in the use of on-site clean energy to power and facilitate the operations of its energy-hungry facilities. Sprint has also partnered with clean energy research firms in a bid to seek better ways of investing in clean energy and backup power within the site. The clean energy sources used by Sprint include wind and solar power which has been perfected by the installation of wind turbines and solar panels.
12. HP (Hewlett Packard) as one of the world's top tech companies is as well not left behind when it comes to the exploitation of green energy. The enterprise powers about 20% of its technology and services in helping customers around the globe to become more IT efficient by the use of green energy. Also, the company has recently come up with a goal of sourcing

more than 40% of its cumulative energy consumption from clean energy sources by 2020, and 100% clean energy in the long term.

13. Sony utilizes green energy by predominantly purchasing its power requirements from renewable energy sources. The green energy it purchases is about 88,000,000 kWh which caters to approximately 37% of its yearly energy consumption. This is quite commendable considering the size of the company. The company's drive to use green energy is influenced by its commitment to minimizing its negative environmental impacts and greenhouse gas emissions. Sony believes environmental sustainability is partly achievable by increasing the percentage of renewable energy powering a company's operations and services.
14. SAP is a global leader in the provision of software and its related services. The company has a dedicated branch supporting the use of renewable energy and is devoted to sustainable practices in its operations, designs, and manufacturing. The amount of green energy used annually by the company totals about 86,000,000 kWh. For instance, the company came up with a goal to buy over 350 gigawatt-hours of green energy across the world to power its data centers. At the same time, the company promises to have a neutral carbon footprint.

5. Conclusion

The last couple of decades have seen an explosion in the use of electronic devices that has increased the problems of e-waste emerging as a significant challenge. This, coupled with increasing concerns about global warming, has made the need to manage and contain the environmental problems caused by electronic devices and IT significant and very urgent. This research focused on the concept of Green Computing and the main purpose of this researchis to provide integrated and complete research for Green Computing. First, we give a definition of green computing that defines it as the practice and procedures ofusing computing and other resources in an environmentally responsible manner way while maintaining overall computing performance. Then, we discussed how IT can impact our environment and what is green IT and presented a holistic approach to green IT. We discussed Green IT Framework and Technologies and mention some applications of green computing in detail. Finally, the features of the green computer are mentioned and explained. They are low use of dangerous elements, energy efficiency, recycled materials used for manufacturing, end of life recovery, use of renewable and bio-based materials, longer life, end of life take back facility, and manufacturer's certification. Then the challenges that might face Green Computing. They are the return of investment, disposal of electronic wastes, cost, and design that impedes the adoption of green computing. In the end, it is important to recapitulation the main points related to the future work of greencomputing which are use products that support green IT in all government sectors, publishing awareness among citizens and businesses about the importance of greencomputing, and how we can apply it, replace all computers with thin-client computers to reduce energy consumption and cooperation with specialized companies to get rid of unwanted computers.

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