

Framework for Implementing Green Information Technology

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Abstract:- Efforts to reduce carbon footprint has long been in discussion as well as action. Carbon footprint is defined as the overall amount of various greenhouse gas emissions, primarily comprising carbon dioxide, emitted due to the actions and choices of an individual, organisation, or nation [8]. Companies are working in the direction of Green Information Technology (GIT) under the pressure of regulation, corporate social responsibility, competitiveness, sustainability and demand for greener products. Like companies allocate budget for innovation and development, similarly budget allocation is necessary for shifting to GIT. Especially for developing countries which want to adopt greener technologies must have an underlying plan to do so. It is easier said than done. Small firms struggle with budget and financing. How can such firms meet their technological requirements at a cheaper and greener way. In order to help the implementation of GIT processes there are regulatory frameworks such as ISO/IEC 33000 and administrative references and governance frameworks for GIT, whose indicators help to standardize processes, and good practices of information technologies and sustainable and eco-friendly communication practices that have the intention of evaluating according to international levels and the organization state towards GIT [5]. Guzman and Juiz [5] deduced that individuals must admit the responsibility of his/her behaviour.

The objective of this work is to study the feasibility of adoption of GIT in terms of social, economic and technological aspects. Here I will also suggest a framework to smoothly adopt GIT and contribute to the environment while making business.

Keywords:- Green Information Technology, Green Supply Chain, Green Distribution, Green Procurement, Green Waste, Green Waste Management, Artificial Intelligence, Cloud Computing, Internet of Things.

I. GREEN INFORMATION TECHNOLOGY

GIT is about using technology wisely. It is the study of operating computers and IT resources efficiently and environmentally friendly way. GIT is study and implementation of design, production, operation and disposal of IT equipment in sustainable way. GIT also includes the development of strategies and tools to control, guide and communicate the green practices adopted by organizations [9].

Computers and computing eat up a lot of natural resources, from the raw materials needed to manufacture them, the power used to run them, and the problems of disposing them at end of life [6]. This is not the end of the list. When you leave a system switched on while not in use consumes power and releases heat which adds to bad environmental practices. Using legacy system also contributes to environmental damage. Here you are wasting energy, time, money and resources. What are you getting in return? Economic loss and pollution which is multiplying every minute due to our negligence and unawareness. When you don't update or change your system, you assume that you are saving money, but this is a greater loss. Fortunately, by doing small things like buying computers which saves energy, has longer battery life, opting for cloud computing technology based on pay per use model and carefully disposing electronic waste (e-waste) will solve multiple problems thus encouraging sustainability. Also, web conferencing is a great way to embrace green. It saves cost of travelling and decreases CO₂ emissions. Moving from paper to digital process will reduce tree cutting and environmental damage. This will also add on to speed of doing business as mailing takes more time than emailing or email marketing. This is one of the reasons why digital marketing is becoming so popular. For instance, researcher Greenspace found that with more than 6,000 customer companies sharing datacentre resources, Netsuite's cloud ERP and CRM solution saved more than \$61 million in energy bills per year, or nearly 595 million kilowatt-hours (kWh), the equivalent of nearly 423,000 metric tons of carbon dioxide per year [6]. Utilizing hosting services from green providers who operate on wind and solar power and employing virtualization can help one move towards Green IT or GIT. Thin client systems run Web browsers, and/or remote desktop virtualization software - such as Microsoft Remote Desktop services, Citrix XenDesktop and VMware View - so you can use the desktop environment that you're used to and with these solutions, you can also extend the life of older PCs and/or buy less expensive, refurbished PCs to save money and reduce waste [6]. Installing carbon emission monitoring systems is a remarkable way to monitor your companies carbon emission. Then to reduce your carbon emission, you can device your plan. These are some of the steps to acknowledge Green IT.

Earlier without accessing the outcomes of our action due to sudden and tremendous economic growth, industrialization and globalization, we have made progress which resulted in environmental problems like – air, land water pollution, pesticides in the food and soil, ultraviolet rays penetrating the ozone layer, emission of greenhouse

gases causing global warming, e-waste generation and their disposal in third world countries, rising of global temperature, population growth, new diseases challenging medical system, effect on ecosystem and so on. Although technology has contributed to providing sanitation facilities; improved air quality in major cities, and constant progression in human conditions [7] but poor environment means limited economic growth thus restricting progress. Today companies are weighing their progress in terms of economic growth, investment, environmental damage and good quality. Here using GIT becomes more crucial so GIT adoption is important in terms of both social and economic aspect. Taking this under consideration, for IT adopted by managers and users in organizations to be considered “green”, in addition to the economic feasibility and operational performance of the system, it is needed to consider environmental, social and ethical aspects in the process of technology acquisition, use and disposal [9]. Above I have already discussed the environmental and economic aspect and its relation and dependency. Social concerns like avoiding child labour, use of harmful chemicals and materials in production, cheating their customers, reducing occupational health, and social pressure has made organizations to move towards Green IT. People are going through social media pages of companies before buying their products or services. They check the companies good work and social as well as environmental contribution before continuing with it further. This change in attitude is forcing companies to rethink their environmental actions and social obligations for staying in the market with economic advantage.

In recent times several frameworks and models have been suggested by researchers but most of them focus on reducing the negative impact of IT and increasing energy efficiency but accessing Green IT is done by few.

II. TECHNOLOGICAL ASPECT OF GIT

Green IT has been gaining relevance in organizations that seek to mature their IT projects, processes and strategies in a sustainable way, encompassing the set of strategies, practices and policies related to Information Systems, IT infrastructure, acquisition, use and disposal with a focus on economic and socio-environmental performance [9]. Every product of IT has an environmental impact and so Green IT becomes more important. Given the optimization of processes offered by the Capability Maturity Model, many frameworks have been developed for different industries such as the Sustainable Information Communication Technology-Capability Maturity Framework (SICT-CMF), Information Technology Capability Maturity Framework (IT-CMF), Maturity Model for Implementing Information Technology Infrastructure Library (ITIL), and Generic Maturity Model for COBIT [10]. These frameworks are useful in measuring how well IT processes are being managed. Green IT takes into consideration 3P's i.e., people, process and profit. In CM level each level is measured by goals achievements that is applied to a predefined set of process area [10]:

- *Level 5 Optimizing: Focuses on the Continuous Improvement of Business Process and Product Sustainable to Sustain and Improve Green Implementation.*
- *Level 4 Advanced: Focuses on the Benefits from Green Implementation Such as the Source of Income of the Organization.*
- *Level 3 Average: Organizations are Implementing Green Practices.*
- *Level 2 Basic: Organizations are Aware of Environmental Sustainability and Initiate Green IT Implementation.*
- *Level 1 Very Low: Organizations do not have a Strategy and Operational Plan to Implement Green IT.*

As stated by Tam and Abdulrahman [10], there are five phases of green product lifecycle which includes designing, manufacturing and facilities, packaging and transportation, being related to manufacturing while procurement, usage and disposal or reuse is at consumer end. So, to implement Green IT successfully, the producer as well as consumer, both must be aware of their responsibilities in keeping environment clean. There are rules and regulation for green procurement and many companies are following it. Reuse and recycle should be prioritized. With software upgradation or hardware part upgradation or replacement old computers must be reused. Even the disposal needs to be in line with the e-waste regulation to minimise environmental damage.

Tam and Abdulrahman [10] have used card sorting method to develop the framework for Green IT procurement, usage and reuse or disposal. It is a good way to analyse if a company is inline with Green IT practices but designing, manufacturing and facilities, and packaging and transportation has not been included in the study. Companies can use the card sorting strategy questions with the customers to see that they follow Green IT.

Here I will be discussing best Green IT practices for designing, manufacturing and facilities, along with packaging and transportation.

III. GREEN SUPPLY CHAIN MANAGEMENT (GSCM)

GIT should be about green designing, green manufacturing and green facilities, green packaging and green transportation, green procurement, green usage and green disposal or green reuse. Supply chain is a part of every company, and it should also be green to support sustainability and for organizations to switch to Green IT.

Supply chain includes managing supply and demand, purchasing raw materials and spare parts, manufacturing and assembling, warehousing and inventory managing, order entry and management, distribution and logistics across all channels and finally delivery to the customer [11]. So, supply chain management (SCM) is covering designing, manufacturing and facilities, along with packaging and transportation as SCM is seamless integration of all these activities into processes. Green supply chain management is

defined as - integrating environmental thinking into supply-chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product its useful life [11]. According to Kim [11], the concept of lean and waste management may come under SCM but this alone cannot reduce the environmental effects made by the supply chain, so the new concept of Green Supply Chain Management (GSCM) emerges to fulfil the environmental demands and make the supply chain more environmental effective.

A. *Qualitative Benefits of GSCM As Stated By Kim [11] are:*

- Improved working condition
- Better Organization in public
- Improved staff morale
- Enhanced customer loyalty/satisfaction
- Establishing or improving brand value
- Lowered regulatory concerns
- Increased market opportunities
- Improved product performance
- Decreased liabilities

- Quantitative benefits of GSCM (Waste related) as stated by Kim [11] are:
 - Reduced waste handling cost
 - Lowered waste categorization cost
 - Reduced waste treatment cost
 - Reduced waste disposal cost
 - Reduced waste storage cost
- Quantitative benefits of GSCM (Lifecycle related) as given by Kim [11] are:
 - Lowered transportation cost
 - Decreased packaging cost
 - Lowered cost of production
 - Low maintenance cost
 - Reduced overall cost of organization

The benefits stated above are highly relatable and valid for Small Scale Industries in India. Based on the above benefits I am discussing Green Supply Chain Management Activities (GSCMA) needed for organizations to move towards Green IT.

Green Supply Chain Management Activities: GSCMA consists of four components mainly Green Procurement, Green Manufacture, Green Distribution and Green Waste Management as shown in Figure 1 below.



Fig 1: Green Supply Chain Activities as extended from Kim [11]

Green Procurement consists of green supplier selection and 7R's [12] (Reuse, Reduce, Recycle, Renew, Replace, Refurbish and Resource consumption). Green Manufacture comprises of hazardous substance control, energy efficient technology, 7R's and waste minimization. Green distribution is about green logistics and green packaging. Green Waste Management involves final treatment/ landfill company, disassembly/recycle plants, waste collectors and waste disposal as per regulation for cleaner environment.

Green Design: It is about waste minimization and environmentally friendly product keeping costing less than usual. Concept of green design mainly focus on three goals for a sustainable future [11]:

- Reduce or minimize the use of non-renewable resources.
- Manage renewable resources to insure sustainability.
- Reducing or eliminating the toxic and other harmful emissions to the environment, including emissions contributing to the environment.

Kim’s thesis [11] suggests some green design methods and tools like mass balance analysis, green indices, design for disassembly and recycling aids, risk analysis, material selection and label advisors and full cost accounting methodologies.

Green Manufacture: Green Manufacturing leads to lower raw material cost, reduces production cost, increases environmental efficiency, reduces occupational hazard, no toxic by-products, development of recycling scheme and lower power consumption.

B. Many Major Production or Manufacturing Process Changes Occur in the Following Categories [11]:

- The dependence changes on human intervention
- Continuous process is preferred instead of batch process
- Changing the nature of the steps in production process
- Eliminating the steps in production process
- Changing cleaning processes
- If the manufacturer opts for continuous automated process, minimizes number of steps in production and makes the cleaning process greener, it will be able to reduce production cost by reducing occupational hazard and increasing environmental efficiency along with cost.

Green Procurement: Green procurement is about purchasing of products and services with minimal impact on environment which are also cost effective. Some typical Green Procurement program elements are [11]:

- Recycled content products
- Energy efficient products and energy efficient standby power devices
- Alternative fuel vehicles, alternative fuels, and fuel-efficient vehicles
- Bio-based products
- Non-ozone depleting substances

- Alternative fuels and fuels efficient vehicles
- Environmental Protection Priority Chemicals

Green Distribution: Distribution consists of many actions, but packaging and transportation are the significant ones. Activities to minimize the negative impact on the environment in the movement of products and services from supplier to customer and vice versa [13] is Green Distribution. Green distribution refers to logistics practices that minimize environmental harm [14]. Green logistics is about waste reduction and less emission thus reducing carbon footprint. Components of Green Distribution are warehousing, packaging and transportation. Follow simple steps like:

- using solar lightening system in warehouse can significantly lower cost as well greenhouse emission,
- using polystyrene foam is bad for aquatic life so bubble wrap or air pillows can be used for sustainable packaging,
- packaging should always use renewable energy and recyclable material,
- for ground transportation alternative fuel for e.g., electric truck can be used,
- maintain your equipment, and
- finally plant trees and restore the forests

By following the above steps, you can easily contribute to environment thus embracing Green Distribution.

Green Waste Management: Waste management is about all the steps required to manage waste, right from its inception to disposal following regulations and updates. Minimise waste by choosing materials that support closed-loop recycling. Closed-loop recycling is when manufacturers can turn recycled materials into the same products many times over without much loss of quality [14].

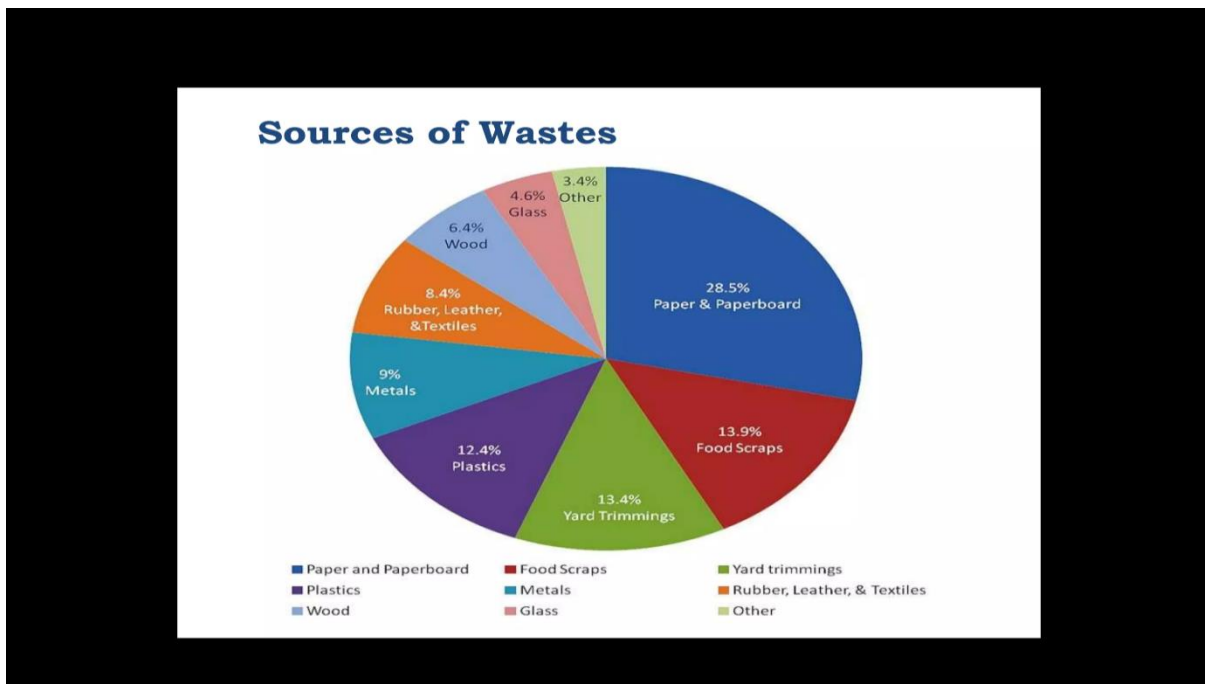


Fig 2: Sources of Waste [15]

Figure 2 clearly shows the sources and distribution of waste, maximum being paper and paperboard while least stated source is glass. With so much of waste generated, where does it go. There is no major problem while disposing organic waste which is biodegradable, but what about inorganic waste. So, you should choose closed-loop recycling material or organic materials for organic waste or properly dispose off waste generated to lessen environmental impact. Acceptable materials must be chosen and 7R's should be followed for Green Waste Management. In this section I have clearly discussed about Green Supply Chain Management Activities (GSCMA) and it is important for Green IT as GIT is about green designing, green manufacturing and green facilities, green packaging and green transportation, green procurement, green usage and green disposal or green reuse, GSCMA covers all of it. The proceeding section will discuss the model of GIT for companies to go green. Here I will be talking about companies that are in CM Level 3 and above.

IV. FRAMEWORK FOR IMPLEMENTING GREEN INFORMATION TECHNOLOGY

Some Green IT frameworks have been suggested earlier like “Governance and Management Framework for Green IT” based on COBIT 5, “Green Information Technology (IT) Framework for energy efficient data canters using virtualization” and many more. Figure 3 shows “Framework for Implementing Green Information Technology” which depends on its five components: Business, People, Process, Technology and, Standards and Regulations. It should be so designed that it should increase profit and minimise pollution. Framework for implementing GIT is shown in Figure 3 below.

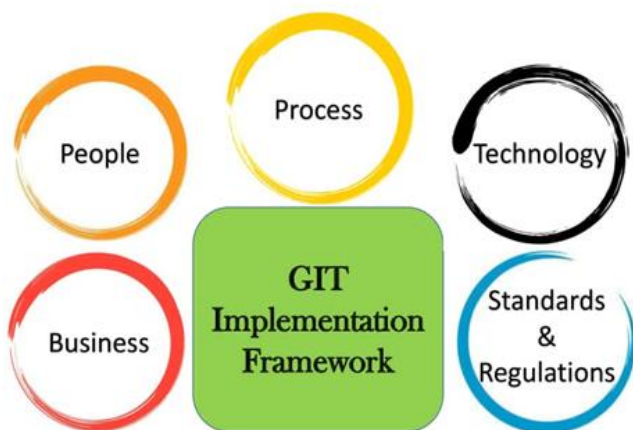


Fig 3: Framework for Implementing Green Information Technology

The first component of Framework for Implementing GIT is Business. Here the nature and role of business is important because people, process and technology will be chosen accordingly keeping standards and regulations in mind. The second component is People who would run the business to achieve desired outcomes. Other than technical expertise and experience, qualities such as [17]: attitude, behaviours, ethics, resources, social-culture, capabilities, values, beliefs, trend in society, knowledge, environmental

orientation, experience, norms, commitment, awareness, and intention are required. Be it business process, manufacturing process or delivery process, the primary focus should be on reducing environmental damage and not compromising on people as well as profit. It is challenging to design such processes but not impossible. Technology here will play key role in achieving your dream of a green organization. Technology components of Green IT are [16]: Cloud Computing, Virtualization, Green Networking and Green Data centres. Cloud computing has already established itself in the market and businesses are widely using it in running their operations. Many of you might not be aware but virtualization is also an indispensable part of technology existing in current time. Green networking and Green data centres are still gaining popularity and soon they will rule the industry. Here along with these four components I suggest that Internet of Things (IOT) and Artificial Intelligence (AI) is a must for Green Information Technology. AI is needed in systems for data analysis and process functioning. Moreover, IOT can be part of security, electrical as well as electronics and waste generation systems. IOT devices have sensors which will sense the environment and act or alert accordingly. The last element of the framework for implementing Green IT is Standards and Regulations. Without following proper standardization and regulatory compliance, complete effort will be useless.

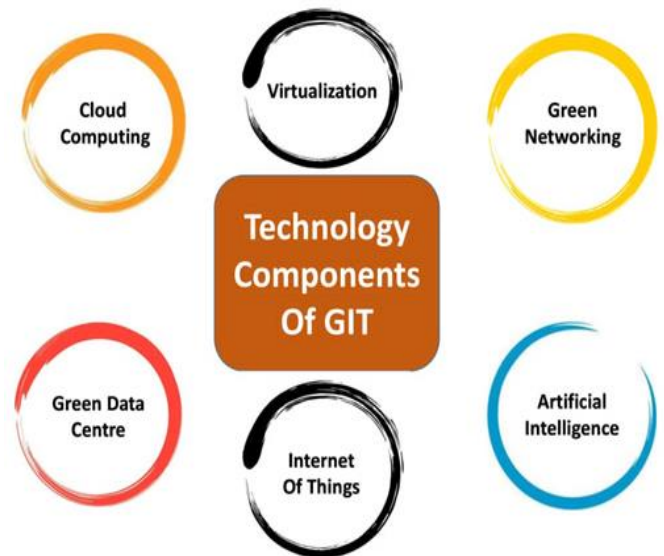


Fig 4: Technology components of Green IT

V. CONCLUSION

In this paper I have successfully suggested “Framework for Implementing Green Information Technology” for businesses. Also, the objective of this work to study the feasibility of adoption of GIT in terms of social, economic and technological aspects has been discussed. It is quite exciting to know that Green IT will reduce the dependence of devices and equipment on power as it is aiming for energy-efficient products and services. India is making significant progress in the field of Green IT and Green energy and so are other nations.

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