

ABSTRACT

1. Introduction

Improving environmental performance, tackling global warming and enhancing resource management are high on the list of global challenges that must be addressed urgently. IT industry is no exception to this. According to a study by McKinsey, IT related production and consumption accounted for about 2% of overall carbon emissions in 2007 (about 0.86 gigatons of emissions a year) which is likely to go up to about 3% by 2020 (about 1.54 gigatons of emissions a year), an increase of about 80% from the current levels. Much of this anticipated increase is because of the high growth rate of computing needs in developed world, technology obsolescence and mounting electronics waste coupled with power guzzling data centers in developing economies. Fortunately, offsetting this concern, IT has the potential to help curb the carbon emissions in the general economy (Mithas et al., 2010: 2). Fast pace growth of IT has created a threat to the environment and hence there is a need to look for environmental sustainability of IT.

The concept of Green IT emerged in 1992 when the U.S. Environmental Protection Agency launched Energy Star¹. It is defined as “Collection of strategic and tactical initiatives that directly reduces the carbon footprint of an organization’s computing operation. However, Green IT is not just focused on reducing the impact of the ICT industry. It is also focused on using the services of ICT to help reduce the organization’s overall carbon footprint.” (Neil, 2011: 4). Thus Green IT aims at managing all IT operations to reduce the environmental impact.

Despite Green IT is emerging as an important concern for business organizations, it still lacks systematic approach towards adoption of sustainable Green IT culture in

¹ An international standard which is efficient ratings used to measure energy. Products bearing the ‘ENERGY STAR’ label are deemed to be more energy-efficient than those that don’t meet the grade, according to the ENERGY STAR specifications.

terms of policy, practices & governance. Overall, Green IT though an emerging area of research, is still by far at nascent stage.

2. Rationale and Significance of the Research

Green IT is now becoming more compelling for IT organizations. It has become imperative for their environmental performance. Issues like power consumption of IT equipment, e-waste, environmental friendly purchasing need to be addressed and planned strategically by the IT organizations. Ignoring the importance of Green IT for companies would naturally lead to higher power costs and will ultimately lead to global warming and exhaustion of natural resources. Although the importance of Green IT implementation has been realized but its implementation is observed to be more of ad-hoc basis rather than well designed matured implementation. It still lacks a systematic approach which can help an organization to assess its Green IT initiatives and provide a logical way to certify the maturity level attained by an organization (Molla, 2008: 660; Sayeed & Gill, 2008: 6; Elliot & Binney, 2008: 7; Molla et al., 2008; 672; Desai & Bhatia, 2011: 50).

Thus, the rationale behind the research was to propose a Green IT management model that that will give a holistic approach to Green IT adoption and will help an organization to evaluate its Green IT maturity.

3. Gap Identification from Literature Review

From the extensive literature review, following major gaps were identified:

- Green IT governance and policy parameters need to be explored in depth.
- Green IT practices need to be explored in depth.
- Need for Green IT management model based on parameters like governance, policy, and practices that will give a holistic approach to Green IT adoption and will help an organization to evaluate its Green IT maturity.
- Academic research so far done in this area is mostly by other countries and shows lack of contribution by Indian researchers.

4. Research Objectives

The current research on Green IT focuses on the following objectives:

- **Primary Objectives**

1. To explore and identify issues and driving factors of Green IT implementation.
2. To explore and identify the parameters of Green IT governance and Green IT policy.
3. To examine and investigate the awareness and implementation of Green IT practices amongst management in selected IT organizations.
4. To propose a framework for Green IT management and to design and develop a Green IT maturity model that can be used to assess the Green IT maturity of an IT organization.

- **Secondary Objectives**

1. To examine and investigate the implementation of Green IT practices amongst employees in selected IT organizations.
2. To know the opinion of employees regarding Green IT implementation in selected IT organizations.

5. Research Hypotheses

The hypotheses of the study are as follows:

1. H₁: Green IT drivers differ in magnitude as claimed by IT organizations.
2. H₂: There is a significant relationship between size of the organization and existence of Green IT policy.
3. H₃: Small, medium sized and large IT organizations differ in implementation of Green IT practices.
4. H₄: Small, medium sized and large IT organizations differ across Green IT governance.

6. Research Methodology

- **Type of Research:** The research conducted is of exploratory and descriptive type. The study has identified various parameters for Green IT governance and policy. Green IT practices under various categories have been explored. The study also describes the current status of Green IT implementation in selected IT organizations.
- **Universe:** IT organizations registered with NASSCOM have been considered as the population of the study. There were 92 IT organizations registered with NASSCOM (as on Jan 2013).
- **Sampling Technique:** The researcher has used proportionate stratified random sampling technique for selecting the sample. The entire population of IT organizations was divided in to three groups - small, medium and large IT organizations. As per definition of small, medium and large IT organizations, there were 20 small, 43 medium sized and 29 large IT organizations. Simple random sampling was performed separately within each stratum.
- **Sample Size:** More than 50% of the entire population was considered. 52 IT organizations were selected for the sample. In order to fulfill the secondary objectives, 2 employees from each IT organizations were considered.
- **Scope:** The scope of the study is restricted to NASSCOM registered IT organizations. The data was collected during the period 2013 and 2015.

- **Source of Data**

- **Primary Data**

Interview and questionnaire methods are the two tools used for primary data collection. The researcher compiled two questionnaires for different category of respondents to gather factual information.

- **Secondary Data**

Approximately 150 research papers and 14 books related to Green IT were reviewed. The literature review covers the following dimensions of Green IT: definition, drivers, issues or concern areas, governance, policy, practices, legislation, benefits, inhibiting factors and Green IT adoption models.

7. Pilot Study

Pilot study was conducted with 10 IT organizations with different employee size (small IT organizations: 4, medium sized organizations: 3, large IT organizations: 3). It assisted in identifying practical problems of the research procedure. Scale reliability of the research instrument was also checked by applying Cronbach' alpha.

8. Data Analysis

The data collected through questionnaire was coded and recorded with the help of SPSS 21. The data analysis carried out is categories as follows:

- **Descriptive Statistics:** Frequency tables were generated and observations were made on percentages. Bar charts and radar charts have been used to highlights the findings.
- **Inferential Statistics:** The various tests were conducted for hypothesis testing.
 - Friedman test was applied to find out the difference in magnitude of Green IT drivers.

- Chi-square test was applied to check whether there is any relationship between size of the organization and existence of Green IT policy.
- Kruskal Wallis test was applied to test whether small, medium and large IT organizations differ across implementation of Green IT practices and governance.

9. Hypothesis Testing

Summary of the hypotheses testing is illustrated in table 1:

Table 1: Summary of the hypotheses testing

Sr. No	Null Hypothesis	Alternate Hypothesis	Test Used	Result
1	Green IT drivers do not differ in magnitude as claimed by IT organizations (mean ranks are equal)	Green IT drivers differ in magnitude as claimed by IT organizations (mean ranks are not equal)	Friedman Test	Null Hypothesis rejected
2	There is no relationship between size of the organization and existence of Green IT policy	There is a significant relationship between size of the organization and existence of Green IT policy	Chi-square test of contingency	Null Hypothesis rejected
3	Small, medium sized and large IT organizations do not differ in implementation of Green IT practices	Small, medium sized and large IT organizations differ in implementation of Green IT practices	Kruskal Wallis	Null Hypothesis rejected
4	Small, medium sized and large IT organizations do not differ across Green IT governance	Small, medium sized and large IT organizations differ across Green IT governance	Kruskal Wallis	Null Hypothesis rejected

10. Key Findings

The key findings of the study are based on data collected through questionnaires and interviews conducted with senior representatives from the IT organizations. The findings of the study are summarized below:

- Recognition of Green IT in India has been comparatively less.
- Reducing cost of IT, corporate strategy and environmental consideration are the top three drivers for Green IT implementation.
- Cost of powering IT infrastructure, IT energy consumption and e-waste management are the top three concern areas.
- Medium sized and small IT organizations do not have Green IT as their critical portfolio.
- Large IT organizations by large follow the Green IT practices, however there is further scope to strengthen their focus.
- Green IT governance is relatively stronger in large IT as compared to medium sized and small IT organizations. But parameters like Green IT audit, formal feedback system, Green IT metrics, and association with Green IT promoting groups are not focused much even in large IT organizations, indicating that the evaluation of Green IT implementation is not done in a systematic way.
- Majority of large IT organizations have mature Green IT policy. Majority of medium sized and small IT organizations do not have Green IT policy although they consider some of the parameters at different stages of IT - purchase, use and disposal.
- Energy efficiency, saving money, reduced office space, easier maintenance of IT systems and positive impact on the environment are the top five benefits experienced by IT organizations due to Green IT implementation.
- Cost of Green IT solutions, inadequate skills and training on Green IT, inadequate funding and lack of government incentives are the most prominent inhibiting factors for medium sized and small IT organizations. Large IT organizations tended to have relatively less barriers as compared to medium sized and small IT organizations.

- Based on the findings of the study, four clusters have been identified. These clusters typify the level of Green IT adoption. These four clusters have been represented as Green IT seekers, Green IT explorers, Green IT enhancers and Green IT experts. Green IT experts show the highest level of Green IT adoption and Green IT seekers show the lowest level of Green IT adoption. The characteristics of these clusters are illustrated in table 2.

Table 2: Characteristics of 4 clusters

Parameters	Cluster 1: GREEN IT Seekers	Cluster 2: GREEN IT Explorers	Cluster 3: GREEN IT Enhancers	Cluster 4: GREEN IT Experts
Most important driver	IT cost reduction	IT cost reduction	corporate strategy and environmental considerations	corporate strategy and environmental considerations
Clarity of Green IT	Some understanding of Green IT	Fair understanding of Green IT	Complete clarity of Green IT	Complete clarity of Green IT
Green IT dimensions- governance, policy and practices	Ad-hoc implementation in Green IT practices and governance	Initiatives taken in all Green IT dimensions	Initiatives taken in all Green IT dimensions	Initiatives taken in all Green IT dimensions
Extent of adoption of Green IT practices	Moderate	Moderate	High	High

Parameters	Cluster 1: GREEN IT Seekers	Cluster 2: GREEN IT Explorers	Cluster 3: GREEN IT Enhancers	Cluster 4: GREEN IT Experts
Salient Green IT governance parameters	Spread Green IT awareness	Spread Green IT awareness, responsibility allocation and encouragement of employees for more initiatives	Target setting for carbon reduction, budget allocation, Specific role creation and training programs	Green IT implementation measured, reviewed and updated through Green IT metrics, Green IT auditing, Green IT reporting and feedback mechanism
Sample	63%	6%	25%	6%
Size of the Organization	Small: 100% Medium:79% Large:18%	Medium:8% Large:6%	Medium:13% Large:59%	Large:18%

11. Recommendations

In order to make the current research more effective, the researcher has suggested the following recommendations.

- Medium sized and small IT organization can spread more Green IT awareness by
 - Encouraging their employees to attend seminars/workshops on Green IT.
 - Forming Green IT club to suggest, identify and spread Green IT practices.
 - Discussing Green IT at social networking sites/ blogs/intranet.
 - Publishing Green IT information on organization’s website.
- Medium sized and small IT organizations can allocate responsibility by having Green IT volunteers or Green IT head as sustainability manager or sustainability head to administer Green IT initiatives.
- Medium sized organizations which looks beyond spreading awareness, can strengthen their Green IT governance by having clear defined roles and

responsibilities, target setting to reduce their carbon footprint, hiring Green IT experts to improve Green IT implementation and conducting training programs for employees.

- For medium sized and small IT organizations, there is a strong need to have stringent guidelines in the form of policy that includes policy parameters along with parameters considered at various stages of IT so that they can channelize their efforts and results in effective implementation of Green IT.
- Large organizations can focus more on Green IT governance parameters like Green IT metrics, Green IT audit, formal feedback mechanism, association with Green IT promoting groups, reward system for employees and enforce Green IT compliance on suppliers to improvise and review their Green IT implementation for optimal performance.
- In order to promote and strengthen Green IT in IT organizations, government should also take initiatives in terms of law enforcement and government incentives.
- A Green IT management and maturity model has been proposed by the current research to address Green IT in systematic way and evaluate Green IT maturity of the IT organizations with respect to Green IT parameters.

12. Green IT Management Model

Green IT implementation is not just adoption of certain practices that help to reduce the impact of IT on environment. It requires a close loop system which guides the organization on various aspects from identifying the need of its implementation, overall administration, to policy framing till evaluating the outcomes of such initiative. It needs a systematic approach which can help an organization to assess its Green IT initiatives and provide a logical way to certify the maturity level attained by an organization. Realizing this need, the conceptual framework of Green IT management and Green IT maturity model has been designed and proposed.

- **Conceptual Framework of Green IT Management**

The conceptual framework will guide organizations to systematically manage their Green IT adoption as depicted in figure 1. It shows the logical and process flow of the various Green IT dimensions. The various dimensions of Green IT have been identified as drivers, issues, Green IT initiative, strategy, governance, policy, practices and Green IT audit as depicted in figure 1. Various actors need to be involved at different dimensions like Green IT advocate is required for coordinating all the Green IT initiatives. Green IT policy needs to be framed by having a steering panel which can include CEO, CTO, CIO, owner, partner, IT department, external Green IT expert etc. This group can act as Green IT advisory team. Other actors like Green IT change agents or volunteers for e.g. employees, line managers etc. for monitoring at operational level, Green IT auditor for periodic Green IT audit need to be involved. This will provide corrective and preventive actions to improve the effectiveness of Green IT adoption in the form of reviewing policy, practices and governance.

The numbered blocks are Green IT dimensions and red block depict the actors at various dimensions. The arrows explain the logical flow of these dimensions.

- **Green IT Maturity Model**

The present research provides a systematic, step by step approach to IT organizations to evaluate their maturity with respect to Green IT preparedness. It also helps organizations to identify the areas for improvement order to achieve the desired maturity. The model to evaluate and identify the Green IT maturity of an IT organization is represented as Green IT maturity model (GITMM) in this research.

The present research has proposed the GITMM that is principally derived from capability Maturity Model (CMM) which is a bench-mark for measuring the maturity of an organization's software processes developed by Software Engineering Institute.

CMM consists of five levels based on process areas. On similar lines, GITMM consists of five maturity levels which are proposed based on the extent of the adoption of the three Green IT dimensions- governance, policy and practices as depicted in figure 2. Each of these dimensions consists of various parameters which are categorized into three levels of importance namely- BASIC, INTERMEDIATE and ADVANCED. All the parameters under these three categories include assessment indicators that will help in evaluating the Green IT maturity with respect three dimensions.

Thus GITMM is a tool to arrive at a symbolic number which represents current maturity level of an IT organization. IT organizations can interpret this level to identify where they are with respect to the fully matured Green IT adopted organizations. It would help them chart the path towards that goal.

The proposed model thus overcomes the limitations of the models developed by Molla (2008) and Sayeed & Gill (2008) by considering three important Green IT dimensions: governance, policy and practices. An in-depth clarity is provided by listing and categorizing the various parameters with their assessment indicators for the above three dimensions. These parameters are largely disregarded in the models by Elliot & Binney. (2008) and Desai & Bhatia. (2011). The assessment criteria have been developed to evaluate the Green IT maturity of an IT organization which is a specific improvement to the model proposed by Molla et al. (2008).

- **Green IT Maturity Model Application**

Case studies were conducted to actually assess the Green IT maturity level for two IT organizations and results were in line with the proposed maturity model.. The assessments were validated as they were agreed by the responsible authorities of the organizations.

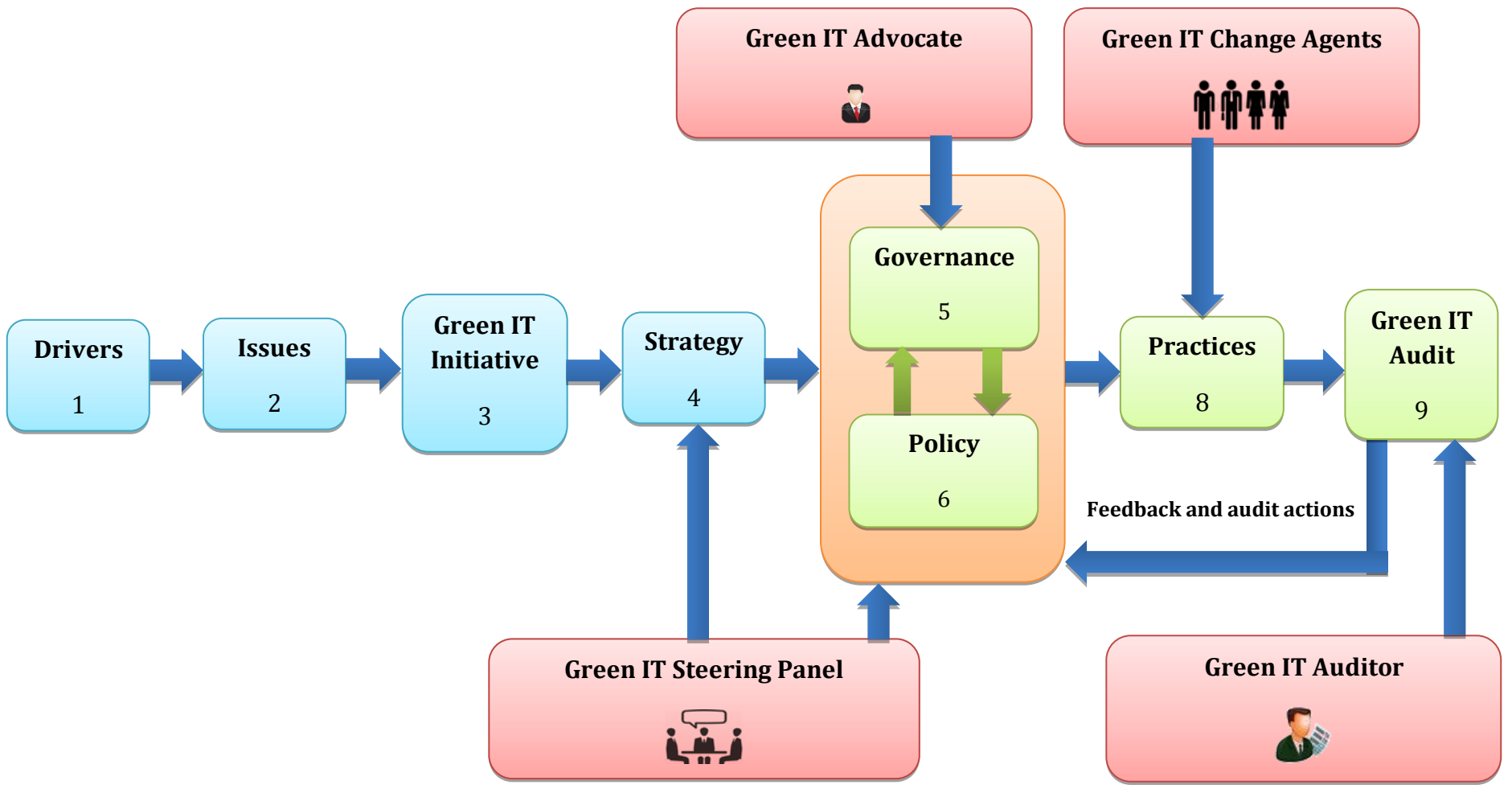


Figure 1: Conceptual framework of Green IT management

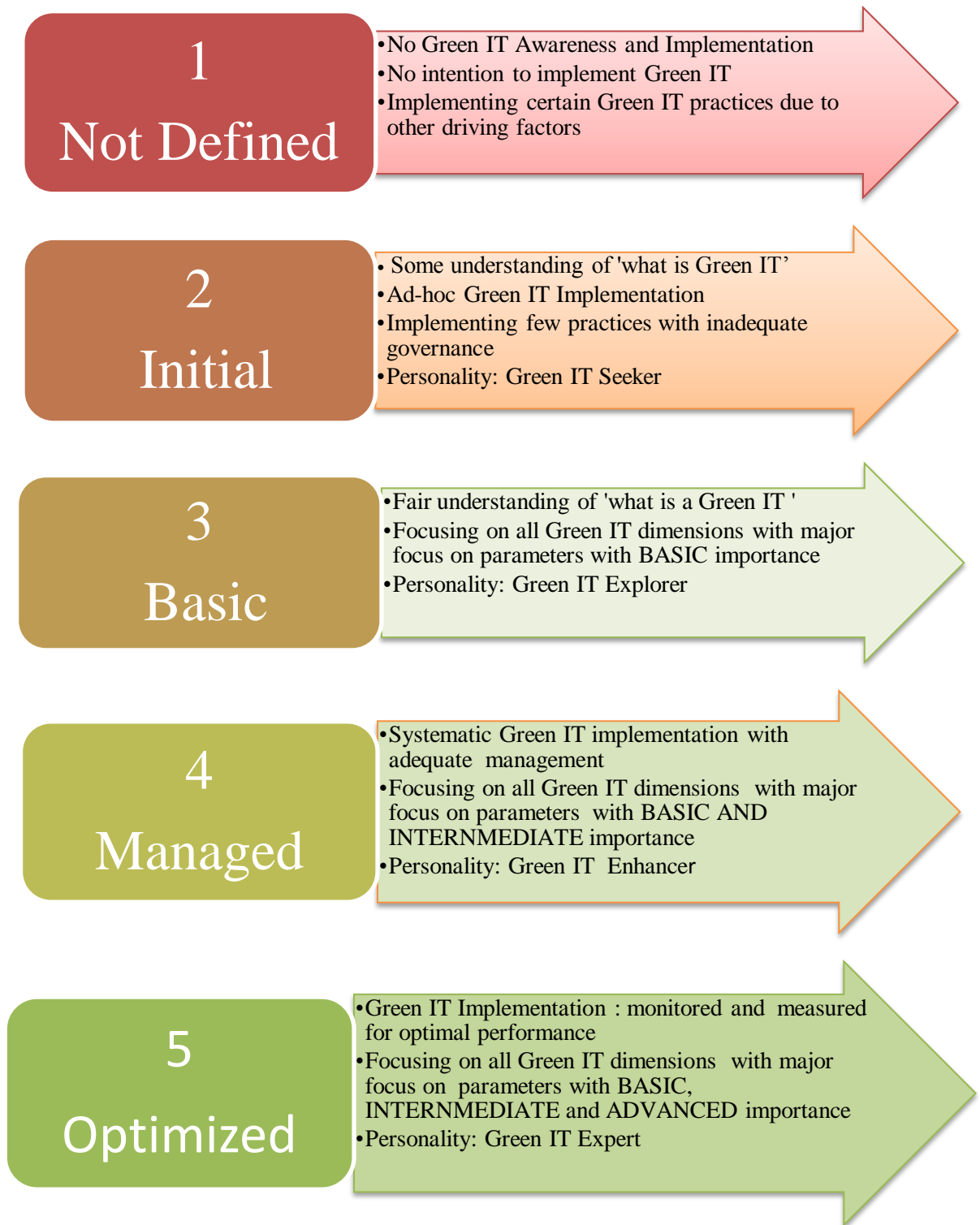


Figure 2: Five levels of Green IT maturity model

13. Contribution of the Research to the Knowledge, Industry and Society

The current study has contributed in the following areas.

- The current study has enabled in-depth exploration of three important dimensions of Green IT viz., governance, policy and practices
- The conceptual framework of Green IT management will help IT organization embrace strong Green IT adoption.
- The proposed Green IT maturity model will provide a tool for IT organizations to evaluate their Green IT maturity.
- The proposed theme of maturity model can also act as base for further research to develop a maturity model that can be applied to other types of industry.
- Green IT adoption in the IT organizations will induce behavioral change among the employees of the organizations. This individual behavioral change leads to societal behavioral change towards adoption of Green IT practices. This in turn leads to a healthy society and greener planet.
- The research thus makes an attempt to contribute towards environmental sustainance.

14. Scope for Further Research

Following arena could be open for onward research from the current research:

- The current study does not consider Green IT practices applicable at IT manufacturing stage. IT manufacturing organizations can be considered to explore these practices and parameters for Green IT policy for environment friendly IT manufacturing can be accompanied.
- The proposed model includes general Green IT practices. Additional practices may be included according to specific hardware.
- The current model is developed for IT organizations. The model may be extended to accommodate other sectors considering factors specific to that sector.

Concluding Remark

Despite having realized the importance of Green IT, not much has been translated in to significant actions. The study has clearly indicated that though initiatives in the form of Green IT practices have been taken but they are largely ad-hoc and reactive rather than holistic and proactive. There is not enough focus on Green IT governance and policy. Green IT management conceptual framework provides a closed loop management system which ensures sustainment and continuous improvement with respect to Green IT adoption. Green IT maturity model (GITMM) proposed by the current research provides a systematic approach to IT organizations to evaluate their current Green IT initiatives and identify the areas for improvement with respect to Green IT parameters. This research work has thus made a step forward toward sustainability of the environment.

Huma U. Lone
Research Student

Dr. Mukund Kale
Research Guide