

CHAPTER – 6

GREEN IT MANAGEMENT AND MATURITY MODEL

6.1 Introduction

This chapter presents a high level Green IT management model. It gives a conceptual picture of different actors and their interaction with functional groups within an organization towards sustainable adoption of Green IT. It shows how a Green IT ecosystem works in a closed loop manner.

The chapter subsequently proposes a tool to assess the Green IT maturity of an IT organization which is derived on the principles of Capability Maturity Model (CMM) that is widely exercised with in IT industry.

6.2 Evolution of Green IT Management Model

The importance of Green IT has been realized by IT organizations. This is reflected in terms of implementation of various Green IT practices in the organizations, but this implementation is observed to be more of ad-hoc basis rather than well designed matured implementation. 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.

6.2.1 Conceptual Framework of Green IT Management

The conceptual framework of Green IT management will guide organizations to systematically manage their Green IT adoption. It shows the logical and process flow of the various Green IT dimensions.

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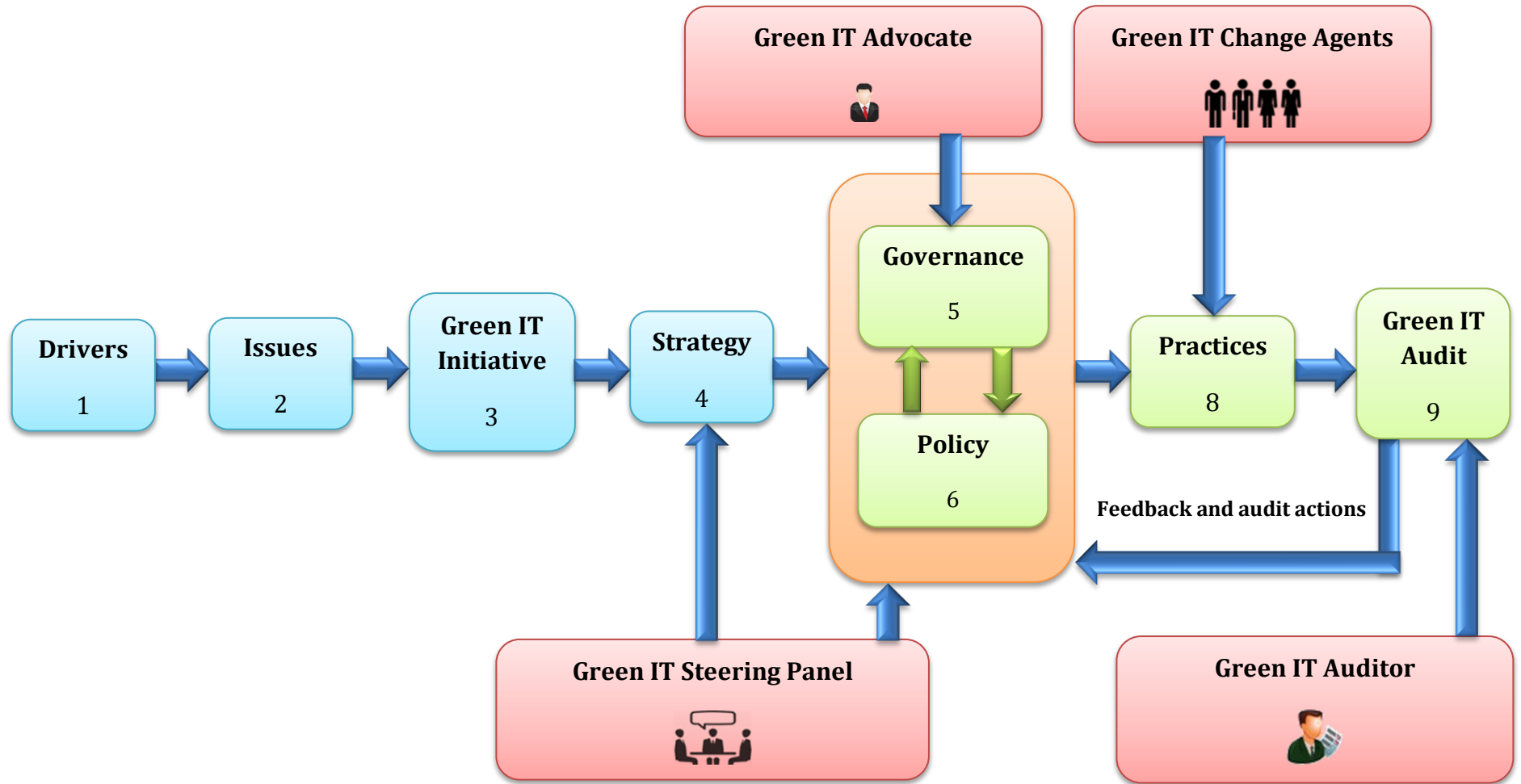


Figure 6.1: Conceptual framework of Green IT management

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Fig 6.1 shows block diagram of the conceptual framework of Green IT management. 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 6.1. 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. These blocks are described below:

1. Drivers

As a first step, it is essential to know the motivation for adopting Green IT by an IT organization. The motivation translates into driving factors for Green IT adoption as shown in figure 6.1 as first block. It could be cost factor which is driving Green IT in an IT organization or can be other factors such as environmental consideration, corporate strategy, government regulations or pressure from clients, vendors, competitors, employees etc. These drivers compel IT organization to identify issues that need to be addressed with regards to Green IT.

2. Issues

Once the motivation for Green IT is clear, the subsequent step is to identify the various issues or concern areas of Green IT which require to be focused and addressed. This can be seen as second block in figure 6.1. The typical issues are environmental friendly purchasing, IT energy consumption, cost of powering IT infrastructure, data center optimization, e-waste management, contribution of IT to reduce carbon footprint etc. Identification of these issues gives the IT organization an initiative for Green IT.

3. Green IT Initiative

With clarity of issues involved in Green IT, the IT organization decides to adopt Green IT as an organization wide initiative and plan to chart the path towards its adoption. This is depicted as block 3 in figure 6.1.

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4. Strategy

Green IT is a strategic and management initiative. Once the organization decides to take this initiative across the organization, a thoughtful strategy needs to be formalized which clearly defines how an organization would set a framework for its Green IT implementation. Green IT strategy is a high level plan for its successful adoption. A **Green IT steering panel** which can include CEO, CTO, CIO, owner, partner, IT department, external Green IT expert etc. shall formalize the Green IT strategy. This group can act as Green IT advisory team. This is depicted as block 4 in figure 6.1.

5. Governance

A strong overall management in the form of Green IT governance must be defined for the overall administration of Green IT initiatives. This includes spreading awareness across the organization, allocating the responsibilities for its implementation, allocating budget dedicated to this initiative, conducting training on Green IT for the employees, setting target for reducing carbon footprint, promoting it by getting associated with Green IT groups like Green Grid and reporting Green IT in the form of sustainability report to the stakeholders. This is depicted as block 5 in figure 6.1. All these activities falling under the umbrella of Green IT requires a **Green IT advocate** who coordinates all the Green IT initiatives. Green IT governance needs to be complemented with a well framed policy which guides an organization to successfully implement Green IT.

6. Policy

The organization needs to frame the policy that includes the directives to address the issues identified. It needs to be framed by consulting the advisory team in the form of Green IT steering panel. This is presented as block 6 in figure 6.1. The Green IT policy should subsequently lead to practices that reduce impact of IT on environment.

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7. Green IT Governance and Policy Collaboration

Green IT governance and policy should work in collaboration. This is depicted as block 7 in figure 6.1. For instance, awareness needs to be created depending on the issues addressed in policy. This can be achieved through training programs on Green IT. Distinct roles can be created to address eco-friendly purchasing, energy efficiency, data center optimization, e-waste management etc. On similar lines budget is allocated for these distinct areas.

8. Practices

Practices under various categories like energy efficiency, environmental friendly purchasing, e-waste management etc. need to be established according to the policy. This is presented as block 8 in figure 6.1 Other actors like **Green IT change agents or volunteers** for e.g. employees, line managers etc. can be assigned at operational level to monitor the implementation of Green IT practices. Emails can be sent to the employees as a reminder to switch off their PCs when not in use. Posters can be put to reduce excessive printing. Implementation of these practices needs to be assessed to realize the benefits.

9. Green IT Audit

The outcome of this initiative needs to be captured, measured and analyzed for sustainment and improvement of this initiative. This is performed by conducting periodic Green IT audit by **Green IT auditor**. The outcomes of the Green IT audit are typically in the form of knowing the degree of adherence to the Green IT compliance standards or benchmarks. The audit also identifies the actionable items that are given as a feedback to the Green IT governing body. The Green IT governing body in turn reviews these action items and makes the necessary modifications/corrections into the Green IT policy and ensures the organization aligns to the revised practices.

Thus the whole Green IT management model performs in a closed loop system that not only sustain but continuously improve over a period of time.

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This system of Green IT management (depicted in figure 6.1) provides a foundation for Green IT management.

6.2.2 Development of Green IT Maturity Model

1. Overview and Need

The conceptual framework describes the various Green IT dimensions for managing it and explains the systematic and logical flow of Green IT dimensions.

However, it is important to know to what extent this model is embraced and exercised by the organization. This in turn indicates the maturity of an organization in its adoption of Green IT. It is therefore very important for an organization to know its level of Green IT maturity so that organizations can identify their roadmap to reach to higher maturity level.

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. It defines a five-level evolutionary path of increasingly organized and systematically more mature processes. These levels consist of different process areas that increase an organization's software process maturity in stages. The levels also help an organization prioritize its improvement efforts (Paulk et al., 1993: 22). These levels are:

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1. Level 1- Initial
2. Level 2- Repeatable
3. Level 3- Defined
4. Level 4- Managed
5. Level 5- Optimizing

At level 1- Initial, the software process is considered as ad-hoc, and sometimes even chaotic. Few processes are defined, and success depends on individual effort (Paulk et al., 1993: 25).

At level 2- Repeatable, basic project management processes are established to track cost, schedule and functionality. The essential process discipline is in place to repeat earlier achievements on projects with similar applications (Paulk et al., 1993: 26).

At level 3- Defined, the software process for both management and engineering activities are documented, standardized, and integrated into a standard software process for the organization. All projects use an approved, tailored version of the organization's standard software process for developing and maintaining software (Paulk et al., 1993: 26).

At level 4- Managed, detailed measures of the software process and product quality are collected. Both the software process and products are quantitatively understood and controlled (Paulk et al., 1993: 26).

At level 5- Optimizing, Continuous process improvement is enabled by quantitative feedback from the process and from piloting innovative ideas and technologies (Paulk et al., 1993: 26).

Green IT Management and Maturity Model

2. Rationale of Green IT Maturity Model

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. These five maturity levels define an ordinal scale for evaluating the maturity of an organization's Green IT adoption. The levels also help an organization to understand the areas where improvement is required with respect to various Green IT parameters under these three Green IT dimensions.

3. Five Levels of Green IT Maturity Model

The present research proposes five levels of maturity as part of GITMM. These levels are based on the extent of adoption which can be assessed by considering various parameters under three Green IT dimensions with three categories namely- BASIC, INTERMEDIATE and ADVANCED. This categorization of parameters has been established based on the importance of the parameters. These three categories viz., BASIC, INTERMEDIATE and ADVANCED are transformed to 5 levels of GITMM. Level 1 is characterized by no intention to implement Green IT. It may have a very small percentage of characteristics of BASIC category with respect to Green IT practices. Implementation of these practices is due to other driving factors like convenience, cost factor, demand of the technology etc. and not because it reduces the impact on environment. Level 2 of GITMM is characterized by primitive or ad-hoc Green IT practices in silos which can map to again a small percentage of benchmarks from BASIC category but with more serious attention. Level 3 of GITMM represents all benchmarks indicated in BASIC category. Level 4 of GITMM represents all benchmarks indicated in INTERMEDIATE category and Level 5 of GITMM represents all benchmarks indicated in ADVANCED category.

These parameters further consist of assessment indicators that help assess the maturity.

Categorization of these parameters is illustrated in table 6.1 below:

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Table 6.1: Categorization of Green IT parameters

Green IT Dimensions	Green IT Parameters		
	Basic	Intermediate	Advanced
Green IT Governance	<ul style="list-style-type: none"> • Spread Green IT awareness • Responsibility Allocation 	<ul style="list-style-type: none"> • Budget allocation • Consultation of Green IT expert • Organization Training • Role Creation • Target setting for carbon reduction 	<ul style="list-style-type: none"> • Green IT promotion • Green IT review • Green IT reporting
Green IT Policy	<ul style="list-style-type: none"> • IT usage reduction and energy efficiency 	<ul style="list-style-type: none"> • IT use to reduce environmental impact • E-waste management 	<ul style="list-style-type: none"> • Advanced IT use to Reduce environmental impact • Environmental friendly IT purchasing / sourcing
Green IT Practices	<ul style="list-style-type: none"> • IT usage reduction and energy efficiency • Data center specific (optional) 	<ul style="list-style-type: none"> • IT use to reduce environmental impact • E-waste management 	<ul style="list-style-type: none"> • Advanced IT use to Reduce environmental impact • Environmental friendly IT purchasing / sourcing

Table 6.2 illustrates assessment indicators for various Green IT parameters. Yes (denoted as Y) can be used to indicate presence and No (denoted as N) can be used to indicate absence of a particular assessment indicator.

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Table: 6.2: Assessment indicators for Green IT parameters

Green IT Dimension: Governance			
Category	Parameter	Assessment Indicator	Metric
Basic	Spread Green IT awareness	Employee Green IT forum/club	Y/N
		Participation of employees in Green IT seminars/workshops	Y/N
		Presence of Green IT at social networking sites/ blogs/intranet	Y/N
		Publishing Green IT information on organization's website	Y/N
	Responsibility allocation	Having Green IT volunteers / Green IT head like Sustainability Manager/ Sustainability Head	Y/N
Intermediate	Budget allocation	Percentage of organization's budget allocated explicitly for Green IT initiatives	Y/N
	Consultation of Green IT expert	Engaging the service of a professional service provider regarding Green IT	Y/N
	Organization training	Employees' training in Green IT	Y/N
	Role creation	Having Green IT hierarchy for Green IT implementation in terms of Green IT steering panel/ Green IT advisory team, Sustainability Manager, Green IT volunteer, Green IT auditors	Y/N
	Target setting for carbon reduction	Setting target for reducing IT carbon foot print in coming 3 to 5 years	Y/N

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Category	Parameters	Assessment Indicator	Metric
Advanced	Green IT promotion	Association with Green IT groups like Green Grid/ USGBC/ IGBC/ any local group	Y/N
		Enforcing Green IT compliance on suppliers	Y/N
		Reward system for employees	Y/N
	Green IT review	Green IT metrics	Y/N
		Green IT auditing	Y/N
		Analyzing IT energy bill separately from the overall corporate bill	Y/N
		Green IT feedback mechanism in any form like Intranet portal to receive suggestions from anybody in the organizations	Y/N
	Green IT reporting	Conducting Green IT annual meeting with shareholders	Y/N
		Publishing Green IT annual report in terms of annual Environmental report/ Sustainability report	Y/N
	Green IT Dimension: Policy		
Basic	IT usage reduction and energy efficiency	Use of IT in an energy efficient manner	Y/N
		Printer optimization	Y/N
		Rightsizing IT equipment	Y/N

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Category	Parameters	Assessment Indicator	Metric
Intermediate	IT use (IT as an enabler) to reduce environmental impact	Energy efficiency technologies	Y/N
		Travel reduction technologies	Y/N
	E-waste management	Environmental friendly IT disposal	Y/N
		IT reuse	Y/N
Advanced	Advanced IT use (IT as an enabler) to reduce environmental impact	IT software to monitor business's carbon footprint	Y/N
	Environmental friendly IT purchasing / sourcing	Energy efficiency	Y/N
		Compliance to applicable Green IT laws	Y/N
		E-waste reduction	Y/N
		Recyclable IT hardware	Y/N
		Vendor evaluation	Y/N
Green IT Dimension: Practices			
Basic	IT usage reduction and energy efficiency	Enforcing PC power management such as switching off the monitor and PC when not in use, using sleep /hibernate mode	Y/N
		Enforcing removal of screen savers	Y/N
		Enforcing data de-duplication	Y/N
		Enforcing removal of software bloats	Y/N
		Enforcing telecommunication strategies	Y/N

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Category	Parameters	Assessment Indicator	Metric
		Enforcing double side printing	Y/N
		Enforcing draft printing	Y/N
		Preferring document sharing services over printing multiple copies	Y/N
		Printing only what you need	Y/N
		Reducing font size for printing	Y/N
		Secure printing	Y/N
		Sharing printer	Y/N
		Using print preview before printing	Y/N
		Monitoring underutilized servers	Y/N
		Retiring energy inefficient hardware	Y/N
	Data Center Specific (Optional)	Airflow management	Y/N
		Airside/Waterside economizer	Y/N
		Free cooling	Y/N
		Hot aisle/ Cool aisle data center layout	Y/N
		Install more energy efficient lights	Y/N
		Localized cooling	Y/N
		Upgrade to more energy efficient transformers and UPS	Y/N

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Category	Parameters	Assessment Indicator	Metric
Intermediate	IT use (IT as an enabler) to reduce environmental impact	Blade server	Y/N
		Cloud computing	Y/N
		Thin clients	Y/N
		Virtualization	Y/N
		Remote conferencing	Y/N
		Remote support/ online services	Y/N
	E-waste management	IT equipment recycling	Y/N
		Donate IT equipment	Y/N
		IT refurbishment	Y/N
Advanced	Advanced IT use (IT as an enabler) to reduce environmental impact	Power down systems	Y/N
		Use of IT energy consumption calculator/ carbon emission management software	Y/N
	Environmental friendly IT purchasing / sourcing	Preferring ink jet printer over laser printer	Y/N
		Preferring laptop over PC	Y/N
		Preferring LCD monitor over CRT monitor	Y/N
		Preferring LED over CCFL LCD monitors	Y/N

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Category	Parameters	Assessment Indicator	Metric
		Shortening IT equipment refresh periods to gain access to more energy efficient equipment	Y/N
		Giving weight to environmental considerations in IT procurement such as ENERGY STAR, ROHS, EPEAT, WEEE etc. or local Eco-labeling	Y/N
		Preferring multifunction devices over printers	Y/N
		Preferring recycled printer cartridge	Y/N
		Preferring IT suppliers that offer take-back options	Y/N
		Preferring IT suppliers that have green track record	Y/N

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The current research proposes the five maturity levels of GITMM. These are:

1. Level 1-Not Defined
2. Level 2-Initial
3. Level 3- Basic
4. Level 4-Managed
5. Level 5-Optimized

These levels of GITMM have been proposed in accordance to five levels of CMM. Since Green IT is a recent initiative by IT organizations, its awareness and intention to implement needs to be considered in level 1. Level 2 of GITMM is characterized by ad-hoc Green IT Implementation. Level 3 indicates basic focus on energy efficiency and increasing the awareness about Green IT. Level 4 represents systematic Green IT implementation along with adequate management by having strong Green IT governance. Level 5 is the highest level which symbolizes monitored and measured Green IT for optimal performance and continuous improvement.

The detail characteristics of these levels are explained below:

- **Level - 1 Not Defined**

At level 1, the organization does not have any intention to implement Green IT. The management of the organization does not have awareness about Green IT. Organization may be implementing certain Green IT practices due to other driving factors like convenience, cost factor, demand of the technology etc. and not because it reduces the impact on environment.

- **Level - 2 Initial**

At level 2, the organization has some understanding of Green IT. The management has intention to implement Green IT. Inadequate understanding leads to ad-hoc implementation where the organization initiates few of the practices with inadequate governance. Organizations at this level can be termed as Green IT Seekers.

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- **Level - 3 Basic**

At level 3, the organization has fair understanding of Green IT. The initiatives have been taken in all the three Green IT dimensions- governance, policy and practices. The extent of implementation is limited to BASIC category parameters. The focus is on energy efficiency and increasing the awareness about Green IT. Responsibilities are allocated to implement Green IT. Employees are encouraged to take more initiatives. Organization focuses majorly on IT use, out of three important stages -IT purchase, IT use and IT disposal. Organizations at this level can be termed as Green IT Explorers.

- **Level - 4 Managed**

At level 4, organization takes initiatives in all the three Green IT dimensions- governance, policy and practices. The extent of Green IT implementation is extended from BASIC to INTERMEDIATE category parameters. Organization looks beyond basic parameters and focuses on how IT can be effectively used to reduce the environmental impact. Green IT governance becomes stronger by setting target for carbon reduction and allocating budget for Green IT implementation. Specific roles are defined to systematically implement Green IT. Green IT training programs are conducted to enhance Green IT implementation. Organization focuses majorly on IT use and IT disposal stages. Organizations at this level can be termed as Green IT Enhancers.

- **Level - 5 Optimized**

At level 5, the organization is focused on continuous improvement in all the three Green IT dimensions- Governance, Policy and Practices. The extent of Green IT implementation is extended from INTERMEDIATE to ADVANCED category parameters. Organization focuses on all the stages -IT purchase, IT use and IT disposal. Effectiveness of Green IT adoption is measured, frequently reviewed and updated through Green IT promotion, Green IT review and Green IT reporting. Green IT auditing and feedback mechanism are the main attributes of optimized level. Organizations at this level can be termed as Green IT Experts.

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Figure 6.2 illustrates the five maturity levels of GITMM.

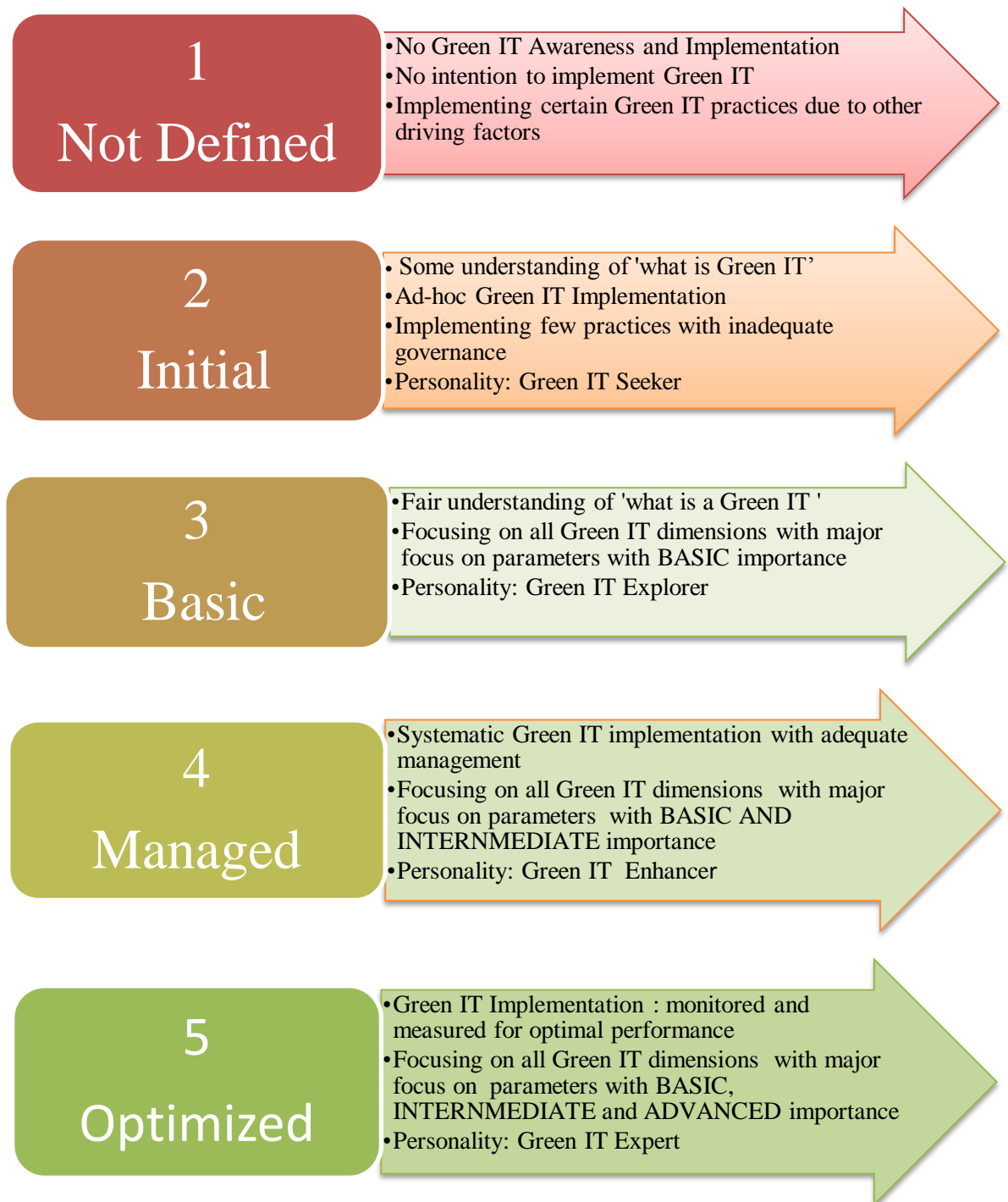


Figure 6.2: Five maturity levels of Green IT maturity model

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4. Maturity Assessment Criteria

In order to evaluate an organization for its Green IT maturity, certain criteria must be satisfied. **To ascend the levels, an organization should satisfy the criteria of the previous levels.** Table 6.3 explains the maturity assessment criteria for evaluating an organization’s Green IT maturity.

Table 6.3: Maturity assessment criteria

Maturity Level	Maturity Assessment Criteria
Level -1 Not Defined	<ul style="list-style-type: none"> • No intention to implement Green IT • No awareness about Green IT
Level-2 Initial	<ul style="list-style-type: none"> • Intention to adopt Green IT • Ad-hoc Green IT implementation • Existence of few practices with little bit of governance • Presence of any combination of three Green IT dimensions with lesser extent of Green IT implementation as compared to level 3
Level-3 Basic	<ul style="list-style-type: none"> • Presence of approx. 60% to 80% of assessment indicators of BASIC category parameters in Green IT governance as depicted in table 6.2 • Green IT policy with BASIC category parameters may be in progress or developed as depicted in table 6.2 • Presence of approx. 60% to 80% of assessment indicators of BASIC category parameters in Green IT practice as depicted in table 6.2
Level-4 Managed	<ul style="list-style-type: none"> • Presence of approx. 60% to 80% of assessment indicators of INTERMEDIATE category parameters in Green IT governance as depicted in table 6.2 • Presence of 100% policy parameters with their assessment indicators of BASIC category as depicted in table 6.2

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	<ul style="list-style-type: none"> • Presence of 100% policy parameters with approx. 75% of assessment indicators of INTERMEDIATE category as depicted in table 6.2 • Presence of approx. 60% to 80% of assessment indicators of INTERMEDIATE category parameters in Green IT practice as depicted in table 6.2
Level-5 Optimized	<ul style="list-style-type: none"> • Presence of approx.70% to 80% of assessment indicators of ADVANCED category parameters in Green IT governance as depicted in table 6.2 • 100% policy parameters with their assessment indicators of BASIC AND INTERMEDIATE category as depicted in table 6.2 • 100% policy parameters with approx. 60% of assessment indicators of ADVANCED category as depicted in table 6.2 • Presence of approx. 70% to 80% of assessment indicators of ADVANCED category parameters in GREEN IT practice as depicted in table 6.2

As depicted in table 6.3 each level has certain maturity assessment criteria. Level 1 is characterized by no intention to implement Green IT. Level 2 of GITMM is characterized by ad-hoc Green IT Implementation. Hence they do not have stringent assessment maturity criteria. Level 3, 4 and 5 are characterized by presence of BASIC, INTERMEDIATE and ADVANCE category parameters respectively along with their assessment indicators with regards to three Green IT dimensions- governance, policy and practices.

6.3 Comparisons with Reported Models

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. More clarity is provided by listing and categorizing the various parameters with their assessment indicators for the above three dimensions.

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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).

6.4 Uses of GITMM

This model can be used in following ways:

- Assesses the current Green IT maturity of an IT organization on various Green IT parameters.
- Recommends various measures that management can take up to reach to targeted Green IT maturity.
- Conceptual framework proposed by the researcher leads to develop theory.
- Act as base for further research to develop a model that can be applied to any industry.

Summary

This chapter has presented the conceptual model of Green IT management. It has explained various functional blocks of Green IT management and organizational actors that influence and govern these blocks. These blocks function in a closed loop management system which ensures sustainment and continuous improvement with respect to Green IT adoption.

The conceptual framework of Green IT management is logically extended and complemented by GITMM. The proposed model represents a notional maturity of IT organization with respect to Green IT adoption. It 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.

This model has been applied on two IT organizations with different employee size to show its efficacy. These case studies are illustrated in the next chapter – Case Studies.