INFORMATION SYSTEMS FLEXIBILITY FOR GREEN TECHNOLOGIES

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Abstract: *Green IT has taken the IT industry by storm and organizations need to be most flexible to accommodate the technologies that prevail in the industry. Green technologies emerge at a very fast rate and organizations need to adopt quickly to keep a competitive edge. IS flexibility plays an important role in aligning its architectures and systems with the changing need of organization and customer demand in the context of Green IT. Each technology goes through a hype cycle and becomes obsolete because of innovations at regular intervals. Hence, flexible information systems designed to accommodate changes in Green Technologies need a special focus as the problem is relevant to modern-day context. This paper proposes a conceptual model that demonstrates IS Flexibility for Green Technologies. It focuses on key aspects of environmental dynamism, IS Flexibility, Organizational Flexibility, Business/Technological Change and Change Process. The change process is explored in the context of Green IT for strengthening the IS Flexibility in organizations.*

Keywords – IS Flexibility, Change Process, Green IT, Sustainable Information Systems, Change Model, Organizational Flexibility

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1. Introduction

One common challenge faced by the IT organizations today is to cope up with the trends in the industry. The recent trend in IT industry is Green IT, where different organizations adopt/provide Green Solutions in innovative ways. One technology which is changing the computing architecture altogether is Cloud Computing. Thinking of Cloud Computing as a potential business opportunity is becoming inevitable for IT organizations. However, grafting new technologies (Green Tech in particular) in business process of an organization could be a cumbersome process and taxing for the IT managers. The information systems should be flexible to incorporate Green Technologies without negatively impacting the business. This comes from a strong support of literature and practice which states that flexibility is the key for coping up with dynamic, uncertain and complex environment (Alter 2000; Chakravarthy 1997; Overby 2001).

Green IT adoption in organizations demand flexible information systems architecture and adaptable application systems and it remains critical issue for IS managers (Prahalad and Krishnan 2002; Sambamurthy et al. 2003). The main feature of information system flexibility is to constantly cater to the changing business trends and dynamically adapt to the volatile environment. As far as Green IT is considered, a few years back Grid Computing was the buzz word in IT industry and within no time Cloud computing became the hottest trend. IT organizations need to live to the trend and business opportunities to gain an edge over their competitors (Leana and Barry, 2000), which is possible only by Information Systems flexibility for Green IT.

The problem of adopting Green Technologies is not limited to IT alone. It has a wide scope across domains in literature. Last decade has shown a much greater concern for environment in terms of contribution to management academic literature (Elkington and Burke, 1989; Purser, 1994; Prothero and McDonagh, 1997). The responsibility of modern day organizations to reduce the impact on environment and create a sustainable society has led to the most important question of how to face the dynamic environment and implement the green initiatives. Management research has played an important role in formulating prescriptions for green initiatives and it is concerned with various aspects of management. Research in Operations Management (OM) has dealt with adoption of environmental quality standards (Corbett and Kirsch 2001), green production (Irwin and Hooper, 1992) and sustainable supply chains (Klassen and Vachon 2003). Studies have been conducted in marketing area examining the consumer adoption of green products and promoting

sustainable business (Belk et al. 1981, Collins et al. 2007) and other green marketing studies like Charter and Polonsky, 1999. Other areas include accounting (Gray *et al*., 1993) and Information Technology (Murugesan, 2004). Literature on Green IT and the role of Information Systems in environmental sustainability has been taken up in the upcoming sections.

The best solutions of green initiatives does not lie in finding out fixtures and short term solutions for reducing the environmental impact, instead it lies in permanently working upon the process in an organization leading to a well define flexible Information Management systems. The emergence of ecologically sustainable organizations depends upon the embedding of environmental beliefs in organization process (Purser, 1994; Jennings and Zandgergen, 1995). This in turn, urges the organizations and green initiative implementers to bring about a radical change in the management philosophy where the role of organization goes beyond the scope of implementing technical fixes and transcend to embracing new environmentally responsible values, beliefs and behaviors (Stead and Stead, 1992; Davis 1994; Shrivastava, 1995). Hence, understanding Information Systems flexibility in Green IT context plays an important role in successfully implementing and sustaining Green IT initiatives.

In order to maintain Information Systems flexibility, it is important to deal with the change and work out a proper model for bringing about organizational change to embrace flexibility in Information Systems. Many models have been demonstrated in literature in context of steps to bring about the green changes (change models) in an organization (Hunt and Auster, 1990; Schot, 1991; Greeno, 1993). However, a sound phased approach to bring about a change concerning Green IT implementation is missing. Therefore, this paper attempts to bridge the gap by taking up the Post-Altman Corporate Greening Model (Post and Altman, 1992) and applying it to Green IT implementation to come up with sound Green IT change model for embracing Information Systems Flexibility.

This paper proceeds as follows. Section 2 describes the literature review of Information System flexibility with details on definitions and types of flexibility. Section 3 brings up the role of Information Systems and environmental sustainability along with the literature review on Green IT. Section 4 proposes a model of Information Systems flexibility of Green IT and elaborates on different aspects of the model in the context of Green IT. This

section also talks about a sound Organizational change process for Green IT implementation that could lead to better information systems flexibility.

2. Information Systems Flexibility-Literature Review

In order to understand information systems flexibility in the context of Green IT, it is important to understand the concept of flexibility. The term flexibility is often considered a vague term because of its wide use in various disciplines. Some studies view it as response capability to changes in organization and environment (Golden & Powell, 2000), while other view it as inherent property of an entity (Avison *et al*., 1995). However, there had been debates on using the word flexibility because of the difficulty in determining how quickly the response should be to call it flexible (Golden & Powell, 2000, Avison *et al*., 1995). The wide use of the term flexibility leads to the problem of the way it has been defined in various disciplines. It is closely related to terms like adaptability, elasticity, versatility, agility etc. Perhaps the best way is to understand the different metrics of flexibility from the research literature. Four metrics were identified by Golden & Powell, 2000: efficiency, responsiveness, versatility, and robustness. They collectively give a fair idea about flexibility in general.

Active support of Information Systems is needed in order to tackle the changes that environment brings in an organization. Not only IS should quickly adapt to the changes, but it should also be done in a cost-effective way. Various definitions of Information System Flexibility have been explored in literature and some of them are presented in Table-1. It is clear from these definitions that IS Flexibility represents the capacity of Information Systems to change/adapt/adjust in response to changes in environment/new conditions/demands/circumstances form the organization. Moreover, Information Systems should do this without a radical change in the existing systems. The response to the crisis should be quick and accurate and IS should bring in good adaptability to environmental changes (Bruns and McFarlan, 1987).

Table-1: Information Systems Flexibility: Literature Insights

Source	Definition/Insight
Mensah (1989)	The ability to respond and adapt to changing business conditions both within and outside the organization.
Duclos et al.	The ability to align information system architectures and systems with

(2003)	the changing information needs of the organization as it responds to changing customer demand.
Palanisamy and Sushil (2003)	The capacity of the information systems to change or to adapt and adjust in response to new conditions, demands, or circumstances from the organization.
Duncan (1995)	IT infrastructure flexibility consist of three components: technological components, flexibility characteristics, and types of indicators
Byrd and Turner (2000)	Measured IT infrastructure flexibility in terms of technical and human IT infrastructure.
Gebauer and Schober (2006)	Factors/ measures for the built-in flexibility of information systems: system functionality, scope of the underlying database, user interface, and processing capacity.
Michelis *et al*., 1998	Change related issues for information systems arise from three areas of concern: systems, group collaboration, organization and the interactions among them

It is important to discuss Information Systems Flexibility in the context of Green IT because IS is viewed as a concoction of several components. It does not focus on a technology alone, but it consists of IT components such as hardware, software, process and data. It is important for any complex IT initiative like Green IT to get aligned with the business process. It has been proved in literature that organizational performance is related to alignment between organizational structures, business strategies and information systems (Chan *et al*., 1997). In undertaking an initiative like Green IT, the organizational structure and business strategies are bound to change because of the changing trends in the IT industry. Therefore, it is extremely important for the information systems to adapt to these changes and be flexible enough to concert with strategies and structures.

3. Green IT- Information Systems and Environmental Sustainability

Studies on Information Systems and Environmental Sustainability have been made in the past. However, it dealt mostly with the use of Information System to deal with the environmental problems. Very few studies actually focused on measures/changes/models to avoid the environmental impact of Information Technology. Information Technology has changed the perception of people of the human nature relationship (Bolter, 1984). It is one of

the important areas to be considered for the study on ecological sustainability due to its revolutionary effects. The term Green IT was coined recently, though the roots of it reside in the earlier studies of IS and environmental sustainability.

Green IT is a synonym to environmentally sound Information Technology (Murugesan, 2008). It includes multiple aspects like environmental sustainability, energy efficiency economics, cost of disposal/recycling etc. Broadly, there are two sides of Green IT; one dealing with IT being the cause of environmental problem and the other using IT/IS to solve the environmental problems. It captures the **technical capability** including choices related to applications, data, technological configurations etc (Broadbent & Weill, 1997) as well as human/managerial capability including experiences, competencies etc of IT personnel (Byrd & Turner, 2000).

Many organizations are altering their business practices to become more environmentally stable (Hendry *et al*., 2005) and this has led to the Green IT adoption. It becomes a Herculean task at times in IT industry to go green and a significant shift in thinking in required to do the same. Hence, the technical expertise of Green IT implementation would not suffice; it is important to study the organization change and green culture with respect to IT. In order to understand the role of IS in forming a green organization culture and how it can drive Green IT, it is important to understand the basic roles of Information Systems. The roles in literature haven been classified as automate, informate and transform (Schein, 1989). These roles can be understood by the relationship explored by Cash et al. (1994). Automation occurs when IT substitutes human effort followed by informate wherein IT augments the human effort. However, when IT restructures, it transforms a set of tasks/processes. Many organizations adopt ecologically responsive measures to avert negative public attention or penalties (Dillon and Fischer, 1992). Information Systems is used by such organizations to facilitate the spread of ecological consciousness and also to take issues to the top management so that green activities are embedded in the business process. The studies dealing with change process models and the organizational barriers in Green IT implementation is in its infancy stage. This paper tries to fill in the gap by understanding the literature of Green Practices in general and applying it in context of Green IT.

4. Proposed Model: IS Flexibility for Green Technologies

The proposed model concentrates on the changes that IS Flexibility must respond to in order to create a flexible organization. The environmental dynamism plays an important role in changing the way organizations work. Both internal and external environments demand flexible organizations and they should be able to adapt in the face of environmental discontinuities (Ciborra 1993). Flexible Information Systems is one of the important elements of Organizational Flexibility and IS should be capable of adapting to new circumstances quickly and inexpensively (Frazelle 1986). Several studies have shown the importance of IS in organizational flexibility (Palanisamy and Sushil 2003; Robey and Boudreau 1999). IS Flexibility should respond to Business Changes and Technological Changes. These changes should be handled with a proper change model so that organizations can leverage upon the IS Flexibility to gain competitive edge. Therefore, the presented model has five components: 1) Environmental Dynamism 2) organizational Flexibility 3) IS Flexibility 4) Business and Technological changes and 5) Change model.

The model presented in this section is applicable for any strategic IS initiative. However, it is discussed in the context of Green Technologies. The last component of the model is also applicable only in context of Green IT because the review of change models was done keeping in mind the context of Green IT and the best one was chosen. Therefore, the first four components of the model are applicable in general for IS Flexibility but is discussed in the context of Green IT. The model is presented in Figure-1.

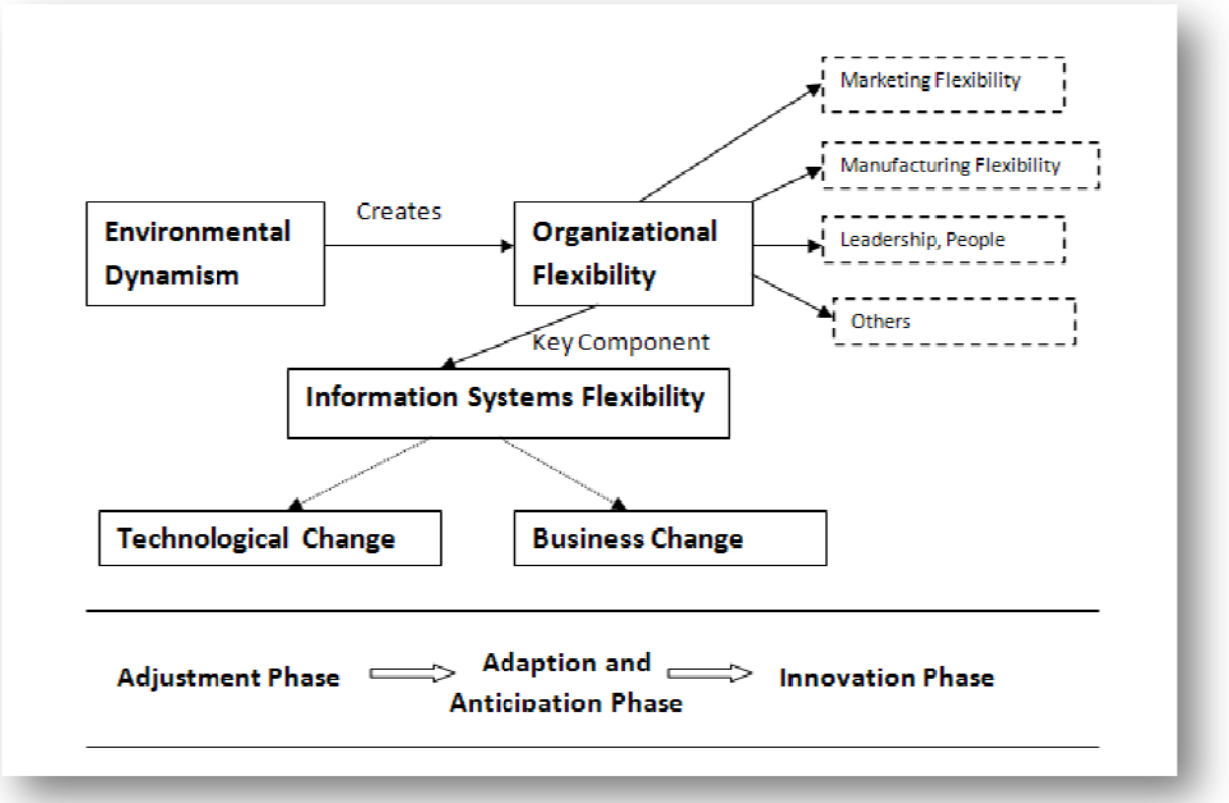

Figure 1: Model- IS Flexibility for Green Technologies

The first component of the model is environmental dynamism. It is defined as unexpected, hard to predict and continuous changes of the environmental forces (Dess and Beerd 1984). It makes an impact on the organization which might result in volatility of the net sales, operating income etc. There are uncertain forces like increased competition, global challenges, market shifts, technological shits etc and environment is conceptualized with them. Environmental dynamism is affected by both external and internal environment. While former deals with issues like competition, customers, supply chain and geographical locations, latter deals with communication, speed and responsiveness. One of the best measures available to capture the construct of environmental dynamism was given by Powell (1993). It is measured by five items: (i) rapid growth in the demand (ii) more need for R&D innovation compare to other industries (iii) the growth stage of the industry (iv) industry characterization such as high-tech and (v) more unstable industry changing more quickly and unpredictably.

Next component of the model focuses on organizational flexibility. In order to deal with the environmental discontinuities, it is important for an organization to be flexible and

adaptable (Ciborra 1993). Leeuw and Volberda (1996) say “organizational flexibility is the degree to which an organization possesses a variety of actual and potential procedures, and the rapidity by which it can implement these procedures, in order to increase the control capability of the management and improve the controllability of the organization and environment.” The speed with which organizations adapt to dynamic environment determines the success of an organization (Hammer and Champy, 1994). There are wide and diverse aspects that come under organizational flexibility that include manufacturing/marketing flexibility, people, and leadership.

Four item can be used to measure organizational flexibility: (i) Frequency of organizational skill-upgrade in traditional and advanced areas (ii) Frequency of organizational response for competition in a more reactive and proactive way (iii) Number of strategies oriented towards organization’s stability and growth and (iv) Frequency of organizational technology-upgrade by indigenous development and import. This scale has been adopted from (Palanisamy and Sushil, 2003)

Out of many important components of organizational flexibility, this paper focuses its study on Information Flexibility. Literature has shown the importance of IS in organizational flexibility and how the role of IS in adopting new circumstances quickly and inexpensively (Frazelle 1986). Several studies have been conducted to understand the impact of IS Flexibility on Organizational Flexibility and efficiency (Palanisamy and Sushil 2003; Robey and Boudreau 1999). In the context of Green IT, it is very clear that world is now facing extreme problem of climate change and IT has contributes to 4% of the Global Carbon Emissions. Hence, it is becoming an important aspect of IT organizations to incorporate Green Solutions in their business process to make it more effective, efficient and eco-friendly. Rigid information systems cannot explore the business opportunities like Green IT and they restrict the organizational capability to exploit opportunities by not allowing changes in the business strategy. Better adapted Information Systems with integration to organization increases possibility of IS implementation success.

Measurement of IS flexibility is adopted from Palanisamy and Sushil, 2003. It uses a four item scale for measuring IS Flexibility : (i) Frequency of IS support for operational and strategic management (ii) Frequency of IS support for organization’s strategic changes in a more passive and active way (iii) Frequency of IS application development for individual and

workgroup and (iv) Frequency of proactive and reactive type of information availability for strategic changes.

Next component of the model is one of the most important aspects of this study. It talks about the changes which IS Flexibility should respond to and therefore sets a path for building a change model that can guide effective IS Flexibility in Green IT. Though the types of changes and its aspects are generic in nature, it has been discussed in the context of Green IT. As already discussed, there are changes constantly occurring in the environment and they need to be addressed effectively with the opportunities presented by the changes (FitzGerald and Siddiqui 2002). Therefore, there is significant pressure on organizations to respond to the changes. Changes in IS environment include both internal & external business environment as well as Technology changes after the implementation of strategic IS initiatives like Green IT.

Responding to change has always been key feature of IS Flexibility. Rate of change & Unpredictability of Change are the major constituents of environmental dynamism which has been found to moderate the relationship between flexibility and performance (Lee 2003). Some of the changes like business & technological change, changes in scope/objectives and instability of technological architecture introduce major risk in IT implementation initiatives (Schmidt et al. 2001). For example- Cloud Computing is taking the IT industry by storm and it involves a complete shift of architecture from legacy in house servers to cloud servers. It involves many changes and issues like security, efficiency, business objective, resource utilization etc. We discuss two major changes that organizations must respond to: Business Changes and Technological changes.

Business Changes: System Providers are one of the major stakeholders in IS Flexibility. They should provide built-in flexibility in the Information Systems to accommodate unpredictable changes in future. The systems should be designed in such a way that that business changes would result in inexpensive and quick accommodation when IS is concerned. In rapidly changing technological world, Green Technologies might direct the business objectives and IS should efficiently adopt new Green technologies in their architecture. One method is to integrate sustainability in the business process of organization. This would increase flexibility in terms of Green Technologies which are mere fixtures rather than permanent solution. It is important to understand the Business Changes because it results

in changes in user requirements (Jalote 2000; Whitten et al. 2001). These changes can be in technical/non-technical requirements, logical internal/interface files, external inquiries etc.

Business changes have been talked about in literature. One of the classifications is given by Lee and Xia (2005) where three groups of business changes have been defined (i) changes in the setup of an IS development project such as system delivery date and budget for the project; (ii) changes in the functional requirements such as system objectives, system scope, input data, output data, business rules/ processes, data structure and user interface; and (iii) changes in non-functional or operational requirements, such as system throughput, system response time, system reliability, and documentation.

The first group in the classification of business changes essentially deals with characteristics of project's setup. In Green IT, when the trend of projects is moving towards eco-friendliness, it is necessary to involve the aspects of sustainability in the IS Setup. It might also affect the business process and functional requirements which is mentioned in the second group. User might prefer a greener product with efficient resource utilization and hence it becomes important to change the system scope right from the design phase. Green IT has great influence in the third group where operational requirement changes. It becomes important in Green IT to provide justification of return on investment and hence the operational changes bring in business value by effective resource utilization, less carbon emissions, less wastage and reduced time.

It is not only the business changes that IS flexibility must respond to. It is important to understand that there are there are technological changes during and after the implementation of strategic Information Systems initiatives like Green IT. Stakeholders of System Development deal with changes in s/w development tools and infrastructure technologies (Cooprider and Henderson, 1991). There are three groups of technological changes given by Lee and Xia (2005). (i) changes in software programming languages/ tools, systems analysis/design methods, and CASE tools; (ii) changes in technology architecture, hardware platform, operating systems, network/telecommunication, and infrastructure; and (iii) changes in the other systems that the application under development will interface with, and in the enterprise master data that the application will use.

In the context of Green IT, where IT firms are looking forward to adopt cloud computing. There is a potential technological change involved in moving from traditional in-house software development method to performing action in cloud. Salesforce.com is an

example of Customer Relationship Management software based in cloud. In case an organization opts for developing CRM software on salesforce.com it has to face a potential shift from traditional software development life cycle to cloud. This will involve changes in tools, architecture and other system changes defined in the classification of technological changes.

The next step in the model provides an important insight on the process bringing about a change in Organization to implement Green IT initiatives. IS flexibility must not only respond to business and technological changes but it should also incorporate a sound change model to accommodate the changes. This step of the proposed model highlights a sound change process to strengthen the IS Flexibility. Various models were reviewed in literature keeping in mind the context of Green IT and the best of literature have been incorporated in the proposed change process.

Many models exist in literature, which talk about general change models like Lewin Three-Stage model (Lewin, 1951) and also environmental change process (Hunt and Auster, 1990; Schot, 1991; Greeno, 1993). However, when Green IT is concerned, there are only some guidelines suggested by Murugesan, 2008 which sets a base for change models in Green IT. Hence, this paper takes up the Post-Altman Corporate Greening Model (Post and Altman, 1992) due to its consistency with the guidelines for change suggested in Green IT literature. Each stage of the model is analyzed from Green IT perspective that could provide an insight for organizations looking to implement Green IT. Also, the key criteria for corporate sustainability have been described for each stage from literature.

Post-Altman Corporate Greening Model linked concepts from corporate responsiveness and organizational learning literatures. The study behind the development of this model concluded that the sample companies went through a development process of response to environmental factors that included important elements of organizational learning. This learning resulted in the transformational change model of corporate greening, the three phases of which are described below.

Adjustment Phase: This marks the beginning of the process, wherein the green implementation kick starts by modifying certain current practices on a need basis. It might be attributed to the market driven pressures where environmental staffs have narrow technical focus. The effort is reactive and incremental in nature directed more towards compliance reporting requirements. In Green IT implementation, this phase is the Tactical Incremental

Approach suggested my Murugesan, 2008. It is the basic step towards implementation of Green IT, where the enterprise preserves its basic IT infrastructure and policies. It goes for simple measures to create awareness in organization abut Green practices. It involves practices like power management, switching off computers, screen saver practices etc. It is easy to implement and has low cost associated with it, however creating a change in organization is the major concern here. The vision at this stage should be to go beyond incremental adjustments and to exceed the compliance requirements. The key criterion for corporate sustainability at this stage is "eco-efficiency". It is one the three criterion (others being eco-equity and eco-effectiveness) suggested by Dyllick and Hockerts, 2002. Eco-efficiency basically reflects an organization's ecological impact in economic terms (Schaltegger and Sturm, 1998). It utilizes the same systems in place and tries to remove the basic problems and make the overall system more eco-friendly and efficient.

Adaption and Anticipation Phase: Here, the linking of environmental value to other corporate values takes place. Old assumptions are questioned and the environmental goals are aligned with the business goals. In green IT, this phase would be the strategic approach. This is a much detailed implementation strategy where an enterprise conducts an audit of its present IT infrastructure with relation to its impact on environment. It develops a comprehensive plan to cater to the broader requirements like using energy efficient systems in the entire organization. The central goal of adaption and anticipation phase remains cost efficiency and reduced carbon foot print. It also contributes to branding, image creation, and marketing (positioning as an eco-friendly firm). Leadership is an important aspect here; however the role of internal champion would boost up the process. The criterion for corporate sustainability at this stage is "eco-equity". It requires fair distribution of natural resources between current and future generations. It is necessary to transcend the compliance and conformity to environmental standards or else the results could be superficial (Meyer and Rowan, 1977).

Innovation Phase: It requires considerable examination and evaluation of environmental goals which become truly embedded in all parts of the company. This stage has an integrated vision (both economic and environmental) incorporating all product/processes in a firm. Apart from clarity of vision, the performance goals should be clear and innovative opportunity development should be encouraged through organizational incentives (Bringer and Benforado, 1993). This would involve a Deep Green Approach in Green IT. This approach is an add-on to the strategic approach, where further initiatives like

carbon offset policy, buying carbon credits etc are taken up. This gives them a competitive advantage is terms of positioning their firm as “Green Firm”, to attract customers supporting green initiatives. This stage sets up the platform for IT product/process innovations. The criterion for corporate sustainability here is “eco-effectiveness” which aims beyond merely reducing the negative impact on environment. It seeks ultimate solution to the problem as embeds it in the organization process requiring a major shift of mindset and transformation of business models.

6. Conclusion

This paper has considered Information Flexibility from Green IT point of view. It has touched upon the importance of IS Flexibility and its role in Organizational Flexibility. It proposes a model for IS Flexibility for Green Technologies. This model brings in an important aspect of Business/Technological changes which IS Flexibility must respond to. Further, it proposes a change process to bring in a sound change when Green IT is implemented to strengthen the Information Systems Flexibility. The paper hints at the fact that success of Green IT initiatives could depend upon integrating environmental issue with corporate strategy. Many executives declared themselves committed to the same (Adams, 1992; Walley and Whitehead, 1994). Also, the commitment from top management is crucial in such change process (Post and Altman, 1994).

Future research would involve applying the suggested model in an IT firm and observing the results. For most of the components of the presented model, the measures for measuring the construct is also provided. This could lead to development of potential hypothesis in the field of IS Flexibility and Green IT. A strong empirical support to the model could enhance the generalizability of the same.

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