

# An Exploration of the Impact of the Use of Standard Management Models on the Adoption of Green IT

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**Abstract**—This paper explores the extent to which senior managers using standard management models as tools for developing corporate strategy, structures and culture are likely to be encouraged to adopt green IT. A range of standard management models are considered: strategic, tactical and operational. Analysis reveals that many standard models, in particular older ones that rely heavily on numbers and take a narrow view of corporate responsibility, are not favourable to the adoption of green IT. Accordingly, managers need to avoid excessive reliance on such models and should consider using models which take account of softer issues, in particular those models which address sustainability directly. There is a need for the development of new management models, which more explicitly integrate traditional bottom line considerations with the wider ethical responsibilities of companies, including sustainability.

**Keywords**—Green, Sustainability, Information Technology, Organizational Culture, Management Models.

## I. INTRODUCTION

The sustainable use of resources is a key issue facing the human race. It is widely accepted that the emission of Greenhouse gases has affected the climate. Other issues include pollution and the careless disposal of waste.

Information Technology makes a major contribution to Greenhouse gas emissions, producing around 2% of global carbon dioxide emissions. However, IT can also contribute to the reduction of pollution through technologies such as “smart cities” and environmental monitoring systems.

There has been pressure on individual companies to take note of environmental issues [1]. This has come not only from the need to comply with environmental legislation, but also from consumer pressure and concern about reputation. Many companies now accept that economic performance is not the only measure of success and have adopted a “Triple Bottom Line” of environment, society and economic performance [2] [3].

In determining corporate strategy and organizational structures senior managers often seek guidance from the standard management models taught in business schools. The extent to which these models encourage the adoption of green IT will, therefore, have an effect on the extent to which managers regard green IT as a serious, mainstream issue.

The remainder of the paper is structured as follows: Section 2 looks at the green agenda, focusing in particular on green IT. Section 3 explores management and organizational models which specifically address green IT. Section 4 investigates the

extent to which standard management models are favourable to green IT. Finally, there are some concluding observations.

## II. THE GREEN AGENDA

The definition of sustainability provided by the Brundtland Commission has gained widespread acceptance: “Development that meets the needs of the present without compromising the ability of future generations to meet their needs”[4]. There has been a number of agreements, most recently the Paris Agreement in 2016. Its central aim was to strengthen the global response to the threat of climate change, by keeping the global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius [5].

Jenkin et al.[6] distinguish between “Green IT” and “Green IS”. “Green IT” is the attempt to reduce energy consumption and waste associated with the use of both hardware and software. “Green IS” they define as the use of information systems to support environmental sustainability initiatives, as in “smart cities”. Here we use “Green IT” as a generic term, covering both efforts to reduce the environmental damage caused by the use of IT and the use of IT in a positive way to support sustainability objectives.

IT has played an increasingly important role in industry and commerce and makes a substantial contribution to the environmental footprints of companies, through both the use of IT and the construction and disposal of IT equipment [7]. It is estimated that IT is responsible for around 2% of worldwide carbon dioxide emissions [8]. Energy and resources are consumed throughout the IT lifecycle. Furthermore, the Basel Action Network estimates that 80% of electronic waste is sent for recycling to the developing world [9]. Computing equipment contains highly toxic materials such as cadmium.

A number of national and international laws have been introduced to tackle this issue. The European Union Waste and Electronic Equipment (WEEE) directive (2003) requires producers, importers and resellers of electronic equipment to dispose of, refurbish or recycle equipment in an environmentally sound manner. The Japanese Home Electronics Recycling Law (1998) has similar requirements. Sustainability issues should be considered at all stages of the software lifecycle.

Software as a Service (SAAS) and Cloud Computing offer ways for using IT resources more efficiently. Companies purchase data storage and rent software, as required, from external providers. These can be accessed using “thin client” computers.

However, the IT data centres which these technologies require have a major carbon footprint. It is estimated that data centres produce 150 million tonnes of carbon each year. Server virtualization has provided the opportunity for servers to be used more efficiently; this allows several servers to be consolidated as virtual servers on one physical server, enabling sharing of resources and economies of scale.

The application of IT can make a positive contribution to sustainability in various ways. Environmental information systems and “intelligent buildings” help to reduce energy wastage; supply chain information systems optimize routing and transportation [10]. Dao et al. [11] argue for combining IT resources with supply chain management and human resource management within an integrated sustainability framework,

### III. MANAGEMENT AND ORGANIZATIONAL MODELS FOR GREEN IT

Bokolo et al. [12] provide a systematic and up-to-date review of literature on green IT. This illustrates that much effort, across a number of disciplines, has been put into developing models and frameworks for analysing green IT.

Murugesan and Gangadharan [13] divide enterprise green IT strategy into three approaches.

*Tactical Incremental Approach.* In this approach, the company retains the existing infrastructure and policies and introduces simple measures such as switching off computers when not in use.

*Strategic Approach.* In this approach, the company develops a comprehensive plan for making its deployment of IT more energy-efficient.

Companies following a *Deep Green Approach* go beyond the *Tactical Incremental Approach*, adopting additional measures such as a carbon offset policy to neutralize greenhouse gas emissions.

One of the mostly widely-cited models is Molla and Cooper’s “Green IT Readiness” or “G-Readiness” framework. It divides IT into IT Managerial Capability, IT Human Capability and IT Technical Capability. An organization’s green IT maturity is assessed in terms of attitude, policy, practice, technology and governance. There is an accompanying G-Readiness Survey instrument.

Deng and Ji undertook a review of the literature, seeking to identify the motivating factors for companies to adopt green IT [14]. They noted that the literature has “scattered theoretical foundations”, but identified the following key underlying theories.

The *Diffusion of Innovation Theory* investigates the process by which innovations spread.

*Institutional Theory* analyses the pressures which influence the development of organizations. A key institutional pressure is “mimetic isomorphism”, the tendency of companies to follow leading companies in their field.

*Organizational Culture* views organizations as social structures and examines the way shared assumptions and norms emerge. This is discussed later in the section on Cameron and Quinn’s Competing Values Framework .

The *Resource Based View* (RBV) [15] takes the view that a company’s competitive advantage resides in its ownership of a

set of resources that are not easily duplicated by a competitor. These resources can be physical, organizational or social.

Hart [16] extends this to the *Natural Resource Based View* (NRBV), by including resources and capabilities particularly relating to sustainability.

Deng and Ji introduce a theoretical framework for “Organizational Green IT Adoption” (OGITA). This has the external drivers of technological context and institutional pressures; and internal drivers of senior management attitudes, corporate strategy and organizational culture.

However, senior managers looking for guidance on changing company strategy, structures and culture are likely to refer to standard management models. The extent to which these models “favour” green IT will, therefore, have a major impact on its adoption. We discuss this in the next section.

### IV. STANDARD MANAGEMENT MODELS

Almost a third (31%) of the world’s largest 500 companies have a chief executive with an MBA [17]. It is likely that the management models they studied will have influenced them in their later careers. We use a standard, widely used and influential book on management models [18]. We follow its separation of models into strategic, tactical and operational. In each case, we explore the extent to which managers employing these models are likely to be encouraged to adopt green IT.

#### A. Strategic Management Models

These models help a company to analyse its strategic position and develop strategic plans for the future.

1) *Ansoff’s Matrix:* Ansoff’s Matrix is a widely used model for helping companies determine their strategy for developing new products and entering new markets [19]. In terms of products, they would have a choice of retaining existing products or developing new products. In term of markets, they would have a choice of focusing on existing markets or developing new markets. This produces four top-level strategies, as illustrated in Figure 1. The top left quadrant is the “conservative” strategy of focusing on existing products and markets; the bottom right quadrant is the “aggressive” strategy of developing new products and seeking new markets.

The model has been extended to a cube, by introducing a geographical dimension, where companies consider expanding into new countries. This is illustrated in Figure 2.

The Ansoff model advises companies to consider four issues: competitive advantage, potential synergies across the company’s core competencies, strategic flexibility (the ability easily to modify strategy to cope with unpredicted events), and the potential for geographical growth.

We now use the OGITA model discussed above to evaluate the extent to which use of the Ansoff Matrix would be likely to encourage companies to adopt green IT. We first consider external pressures.

From a technology perspective, the questions would be:

- Would going green give the company a relative technological advantage?
- Would it be technically challenging?
- Would it make use of core technical competencies within the company?



Figure 1. Ansoff Matrix

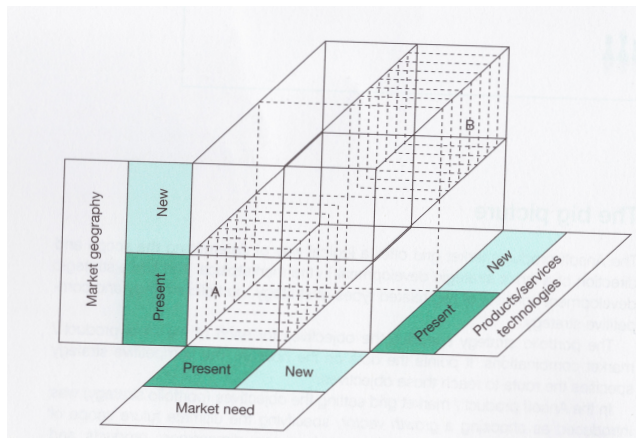


Figure 2. Ansoff Cube [18]

In considering these issues, technological experts within the company would be considering the challenges of developing new products, against the backdrop of the possibility of just going for greater market penetration in existing markets or developing new markets. Unless there was a compelling reason to suppose that the greener product would provide a competitive technical advantage or the existing product would become obsolete because of its poor green credentials, technology experts would be likely to favour avoiding radical changes to the existing product portfolio.

We noted above that there are essentially two types of green IT: those which try to avoid negative environmental impacts of IT-related products and those which use information systems to promote sustainability in applications such as environmental monitoring and smart cities. The latter are likely to involve developing radically new products and be much more challenging in technical terms. They are likely, therefore, to be deemed unattractive.

From the perspective of external institutional pressures, the questions would be:

- Will the company be breaking the law, if it does not make its products greener?
- Will the company become out of step with the market if it does not become greener?
- Does the company face a risk of reputational damage?

Unless the company is driven by a powerful “mimetic isomorphism” pressure, external pressures for greenness are unlikely to be stronger than economic pressures.

Finally, we consider the internal motivations of the OSITA framework. Senior managers tend to be driven by numbers and verifiable evidence. It is likely to be easier to provide clear evidence for the benefits of taking existing products into new markets than to demonstrate that a market will exist for radical new green products. Many green products are “disruptive technologies”, for which there is currently no market. As Christensen argues in his influential work “The Innovator’s Dilemma”, the company culture is frequently hostile to such technologies [20]. Unless there are a number of green champions within the company at a senior level, top managers are likely to favour developing markets and making only incremental changes to existing products.

In summary, the Ansoff model is likely to discourage companies from developing new greener products, because it juxtaposes the challenge of developing radical new products with the easier option of expanding the market for existing products. Insofar as the use of Ansoff’s Matrix encourages the adoption of green IT, it is likely to be of a “Tactical Incremental” nature, within Murugesan’s taxonomy of green initiatives discussed above.

2) *Porter’s Five Forces*: Porter’s Five Forces is one of the most established management models, and has been used for around forty years. It is used by companies contemplating entering a new industry. It identifies five things that need to be considered:

- New entrants
- Substitutes (will it be easy to replace the proposed product with something else?)
- Buyers
- Suppliers (companies which will be below you in the supply chain)
- Existing Competitors

The employment of Porter’s Five Forces is likely to discourage companies from developing radical new green products and services, for the same reason as Ansoff’s Matrix. As Christenen (discussed above) notes, you cannot analyse a market that does not exist.

3) *The BCG Matrix*: The Boston Consulting Group Matrix goes back to the 1970s [21] [18]. It is used by companies for planning their product portfolio. It is similar to the Ansoff Matrix, having two dimensions; in this case, the dimensions are the projected Market Share and Market Growth. This again creates four main types of market:

- 1) high market share, high growth (best)
- 2) high market share, low growth
- 3) low market share, high growth

#### 4) low market share, low growth (worst)

What “advice” will this model give? The market for a new green Cloud service is likely to be of the third type. The Cloud market is highly competitive but is likely to grow. The market for a new environmental monitoring system for reservoirs is likely to be of the second type. The market is small and unlikely to grow substantially, but it is a small market and a successful product could have reasonable expectations of dominating it. Few green markets are likely to be of the first type. It seems probable that senior decision makers using the BCG will favour potential new markets of the first type rather than green markets.

4) *The Blue Ocean Strategy*: This model makes a distinction between a Red Ocean Strategy, where a company seeks to beat the competition in an existing market; and a Blue Ocean Strategy, where a company seeks to develop a brand new market. It encourages companies to focus on the big picture rather than the numbers [22] [18].

Employment of the Blue Ocean model is likely to be positive for the development of green IT products for new applications, such as the Internet of Things.

5) *Kay’s Distinctive Capabilities*: The Kay’s Distinctive Capabilities (KDC) model originates from the Resource Based View, discussed above, which regards a company as a collection of skills and capacities, many intangible, which cannot easily be imitated. [23] [18]. KDC separates these into three categories:

- Architecture (features intrinsic to the company and its relationships with customers and suppliers)
- Reputation
- Capacity to innovate

To some extent this model encourages green innovation. It acknowledges the value of a company having a reputation for being ethical. Furthermore, the extension of the RBV discussed above, the Natural Resource Based View, explicitly recognizes that green capabilities are likely to be important in the future. But the model emphasises that it is very difficult to convert innovation into competitive advantage. The success of a radical new and efficient Cloud Computing model will be greatly affected by whether competitors are developing a similar product.

#### B. Tactical Management Models

These models help a company to organize its process, resources and people. They address “how to” questions.

1) *Cameron and Quinn’s Competing Values Framework*: Anthropology takes the view that organizations are cultures; sociology takes the view that organizations have cultures [24]. Most organizational theory adopts the sociological perspective, regarding culture as an attribute of an organization that can be measured and analysed. Schein [25] defined organizational culture as: “A pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration that has worked well enough to be considered valid and hence to be taught to new members as the correct way to perceive, think and feel in relation to those problems.”

Schein identified three levels of culture:

- Artifacts, those aspects which are on the surface such as dress and can be easily identified;
- Espoused Values, that is conscious goals, strategies and philosophies;
- Basic Assumptions and Values. These exist at a largely unconscious level, form the inner core of culture and are hard to identify.

Basic Assumptions and Values have the deepest influence and are the most difficult to change. Many attempts at organizational change fail because of a failure to change the underlying culture [26].

Many dimensions of organizational culture have been proposed, for example Hofstede [27]: power distance, uncertainty avoidance, individualism, and masculinity. Cameron and Quinn’s “Competing Values Framework” (CVF) originated from a cluster analysis of these dimension schemes. It identifies two key dimensions: Internal Focus and Integration versus External Focus and Differentiation; and Stability and Control versus Flexibility and Discretion [28] [29]. The CVF has been used in many research studies and has been shown to have a high degree of validity [30].

The four key culture types identified by the CVF are illustrated in Figure 3 and may be summarized as follows (Adapted from [29]):

- Hierarchy. Such organizations tend to be bureaucratic. Formal rules and policies hold the organization together. The long-term goals of the organization are stability, predictability and efficiency. Government agencies and the military are typical hierarchical cultures.
- Market. The workplace is results-oriented. Leaders tend to be aggressive and demanding. The glue that holds the organization together is an emphasis on winning. Success is defined in terms of beating the competition and market share.
- Clan. The organization is held together by loyalty, tradition, and collaboration. It is a friendly place to work, where people share a lot of themselves. Leaders are thought of as mentors and coaches. Success is defined in terms of internal climate and concern for people. The organization places a premium on teamwork, participation, and consensus.
- Adhocracy. The workplace is dynamic, creative, entrepreneurial and risk-oriented. The emphasis is on being at the leading edge of new knowledge, products, and/or services. The glue that holds the organization together is commitment to experimentation and innovation. Success is defined as the production of innovative and original products and services.

The Organizational Culture Assessment Tool (OCAI) consists of a questionnaire requiring employees to assess their organization, using an ipsative scale, on six characteristics: Dominant Characteristics, Organizational Leadership, Management of Employees, Organization Glue, Strategic Emphases and Criteria for Success. A culture profile diagram can then be produced.

The results can be used for various purposes, e.g.: to calculate the average profile of an organization and identify



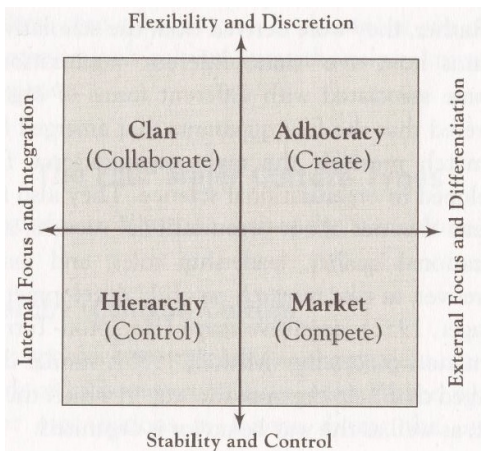


Figure 3. Cameron and Quinn [29]

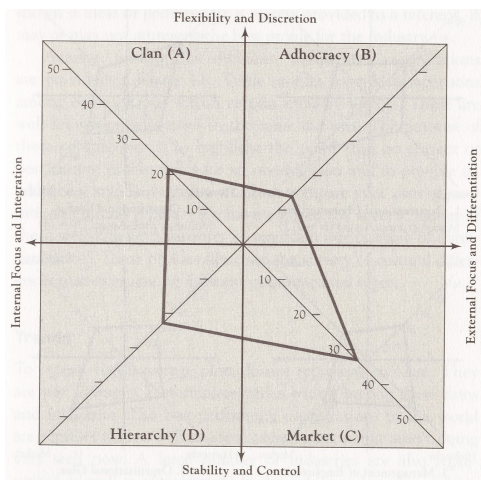


Figure 4. Cameron and Quinn [29]

the main culture types(s); to identify discrepancies between current and preferred culture; and to ascertain the degree of congruence between results produced by different groups of employees. Cameron and Quinn averaged the results for over one thousand companies; this resulted in the average profile in Figure 4.

There has been a considerable amount of research on the relationship between types of organizational culture and effectiveness. Richard et al. [31] conducted a survey of US firms. They found that clan cultures resulted in higher earnings and employee satisfaction.

In the US health industry, Gregory et al. [32] found a positive link between group (clan) culture and patient and physician satisfaction and also a slight link between balanced cultures and satisfaction.

The successful adoption and diffusion of green IT systems is also affected by the organizational culture of companies. Green IT systems are likely to be ‘disruptive technologies’, which are regarded as risky. For example, attempts to reduce energy use associated with data storage through the employment of “cloud computing” may raise fears about security. Green IT systems are, therefore, more likely to be favoured

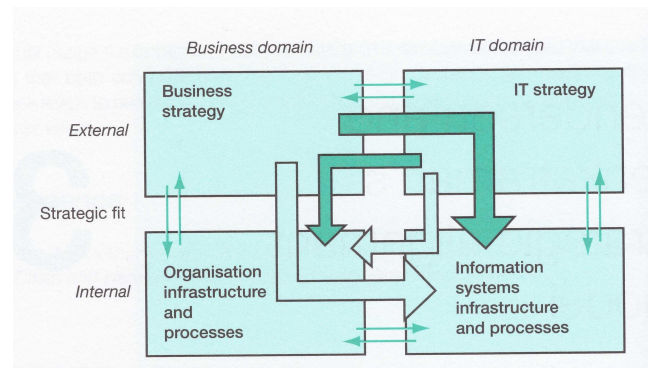


Figure 5. Strategic Alignment Model

by companies with clan or adhocracy cultures, which are non-hierarchical, entrepreneurial and can embrace change.

The use of the Cameron and Quinn model as a framework for discussing the impact of organizational culture on the adoption of green IT is discussed in detail in [33] [34].

2) *Beer and Nohria E and O Theories*: Beer and Nohria is a modern management model, which explicitly emphasises the value of soft skills and the importance of companies behaving ethically and taking account of their corporate social responsibility [35] [18].

They have two main theories of change:

- Theory E. This focuses on the creation of economic value for shareholders. It involves formal systems and structures. The decision making process is top-down. Changes are carefully planned.
- Theory O. This focuses on a culture that develops employee commitment and takes note of a company’s ethical responsibilities. Change is emergent.

To be successful, a company must embrace both Theory E and Theory O and confront the tension between them.

The Beer and Nohria model is favourable to the adoption of green IT, because it encourages managers and employees to think of the bigger picture and not just focus on narrow financial considerations. In particular, it asks companies to take account of their ethical responsibilities. But the model does not ignore the practical exigencies of operating a successful business. For companies successfully to adopt green IT they must both have a vision and have the operational capability to realise it in the real world of business. The Beer and Nohria model provides a framework for constructively reconciling the conflicting pressures this creates.

3) *Henderson and Venkatram’s Strategic Alignment Model*: This model addresses IT strategy directly [36] [18]. It seeks to promote alignment between business strategy and IT strategy and also between the IT infrastructure and business operations. A key feature of this model that it provides for IT strategy influencing business strategy. This is visualized by the counter-clockwise arrow from top-right to bottom left in Figure 5. This is likely to be favourable to the adoption of green IT.

### C. Operational Management Models

These models help a company to optimize operational process and activities.

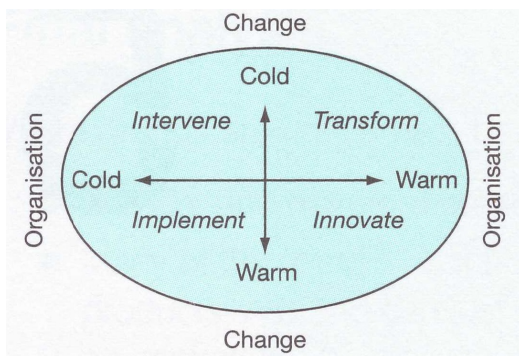


Figure 6. Change Quadrants

The *Change Quadrants* model is a tool to assist companies to effect a particular change [37] [18]. It analyses companies on two dimensions: whether they are “warm” or “cold”; and whether the key motivation for the proposed change is “warm” or “cold”.

A warm organization is one where there is a shared sense of values and employees do not have a merely transactional relationship with the organization. It is rather like the “Clan Culture” in the Cameron and Quinn Competing Values model. A cold organization is one which is hierarchical and governed by rules, systems and procedures.

A warm motivation for a proposed change is driven by a shared sense of values across the company. A cold motivation is a response to a crisis such as the emergence of a dangerous competitor.

This produces the four quadrants in Figure 6. The change strategy should be tailored to the quadrant. A “warm organization that is willing” (the bottom right quadrant) will be open to change. It will be possible to develop a long-term vision bottom-up. A “cold organization that is obligated” (the top left quadrant) will have to drive change top-down; employees will only have a say in the implementational details. The key message of the model is that real transformation, such as is involved in the systematic adoption of green IT, requires a warm organization and a warm motivation for change.

## V. GENERAL CONCLUSIONS ABOUT MANAGEMENT MODELS

Most of the older models are driven by relatively short-term bottom line considerations. These are likely to be unfavourable to green IT. More recent models, such as Beer and Nohria and Change Quadrants, tend to adopt a wider perspective on the responsibilities of companies and also take more note of “softer” people and ethical issues. They are more likely to be favourable towards green IT.

Managers need to be cautious about over-reliance on standard models, especially those which take a narrow view of corporate responsibilities. They should consider employing models which take account of wider issues, in particular those models which incorporate consideration of sustainability.

## VI. CONCLUSION

This paper has considered the extent to which standard management models are likely to support the adoption of green

IT. It explored strategic, tactical and operational management models. It was concluded that many management models are not favourable to the adoption of green IT, in particular many of the older standard management models which do not take a holistic view of corporate responsibilities. It is, therefore, incumbent upon managers not to place excessive reliance on such models.

There is a need for the development of new management models, which more explicitly integrate traditional bottom line considerations with the wider ethical responsibilities of companies, in particular those relating to sustainability.

Future research directions include empirical analysis of the impact of the use of management models on a sustainability culture within IT and consideration of the effect of operating within different cultures. There is also a need for development of more rigorous metrics for green IT.

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