An Analysis of the Extent to which Standard Management Models Encourage 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. Cameron and Quinn's "Competing Values Framework" is used as a tool to explore organizational culture. A statistical analysis of a survey of organizational culture and greenness is presented. It is concluded that organizational culture has a major impact on the adoption of green IT and consideration must be taken of it when introducing green IT initiatives.

Keywords–Green; Sustainability; Green IT; Information Technology; Organizational Culture; Management Models; Statistics.

I. INTRODUCTION

This paper extends [1]. It also builds on [2] and [3], by undertaking a survey on organizational culture and green IT level, using the "Competing Values Framework" and seeking to identify significant statistical correlations.

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. Belkhir and Elmeligi [4] estimate that the carbon footprint of Information and Communication Technology (ICT) will rise from between 1 and 1.6% in 2007 to around 14% in 2040. The global greenhouse gas emissions (GHGE) resulting from ICT will exceed that of the agricultural sector. The sustainable use of resources in a way that does not damage the environment, the so-called "green" agenda, is one of the key issues facing the human race in the early 21st Century. The role of ICT is clearly significant.

However, while ICT significantly contributes to GHGE, it can also contribute to reducing pollution through technologies such as "intelligent buildings", cloud computing and smart logistics.

There has been pressure on individual companies to take note of environmental issues [5]. 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 [6] [7].

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.

Organizational Culture has long been recognized as an issue of great importance within the business literature and, in recent years, substantial attention has been devoted to its impact on the adoption of green initiatives. It has been argued that for companies systematically to incorporate environmental concerns into their activities requires a major change of corporate culture [8][9]. However, there has been limited consideration of the impact of organizational culture on the adoption of green IT. A key theme of this paper is to explore the role of culture within IT, and the extent to which particular types of culture facilitate green initiatives. Cameron and Quinn's "Competing Values Framework" is used as a tool to explore organizational culture.

The remainder of the paper is structured as follows: Section II looks at the green agenda, focusing in particular on green IT. Section III explores management and organizational models, which specifically address green IT. Section IV investigates the extent to which standard management models focusing on strategy are favourable to green IT. Section V investigates the extent to which standard management models focusing on tactics are favourable to green IT. Section VI investigates the extent to which standard management models focusing on operational management are favourable to green IT. Section VII presents some general conclusions about management models.

The following sections present the survey on organizational culture and green IT level. Section VIII considers statistical applications of the Competing Values Framework. Section IX describes the survey and the research methodology. Section X presents the results of the study, along with analysis. Section XI has some discussion of the results, in particular reflecting on

issues which arise when statistically analysing culture surveys. Finally, the Conclusion summarises the key points of the paper, makes some recommendations and looks at possible future research directions.

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"[10]. 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 [11].

The terms "IT" and "ICT" are not clearly distinguished in the literature or in general usage, although "ICT" more explicitly includes the use of communication networks. Jenkin et al. [12] distinguish between "Green IT" and "Green IS" . They define "Green IT" as 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. In this paper we use "Green IT" as a generic term, covering all efforts to reduce the environmental damage caused by the use of IT (including networks), or to use IT in a positive way to improve the environment.

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. IT data centres make a major contribution to the carbon footprint of many corporations. Data centres worldwide are projected to produce around 495 million tonnes of carbon annually by 2020 [4]. The Internet of Things, smartphones and cryptocurrencies are growing sources of GHGE.

However, the application of IT can make a positive contribution to sustainability in various ways. 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. 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.

Environmental information systems and "intelligent buildings" help to reduce energy wastage; supply chain information systems optimize routing and transportation [13]. Dao et al. [14] argue for combining IT resources with supply chain management and human resource management within an integrated sustainability framework.

Green IT must ultimately, in large part, be delivered by companies. In recent years, companies have started to recognise that having a "triple bottom line" of People, Profit and Planet is actually good for profitability. It enhances reputation and encourages the development of valuable capabilities relating to sustainability [7]. Deutsche Bank, for example, has an eight point Green IT policy [15].

III. MANAGEMENT AND ORGANIZATIONAL MODELS FOR GREEN IT

Bokolo et al. [16] 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 [17] 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 *Strategic 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 [18]. 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 [19]. 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) [20] 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 [21] 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. Almost a third (31%) of the world's largest 500 companies have a chief executive with an MBA [22]. It is likely that the management models they

Figure 1. Ansoff Matrix

Figure 2. Ansoff Cube [23]

studied will have influenced them in their later careers. We discuss this in the next section.

We use a standard, widely used and influential book on management models [23]. 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. The extent to which these models "favour" green IT will, therefore, have a major impact on its adoption.

IV. STANDARD MANAGEMENT MODELS FOCUSING ON STRATEGY

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

A. 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 [24]. 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.

We now consider each of the four quadrants from the perspective of green IT. Unless a company is already selling green products, only the two right hand quadrants are relevant. The *Product Development* quadrant would require the promotion of
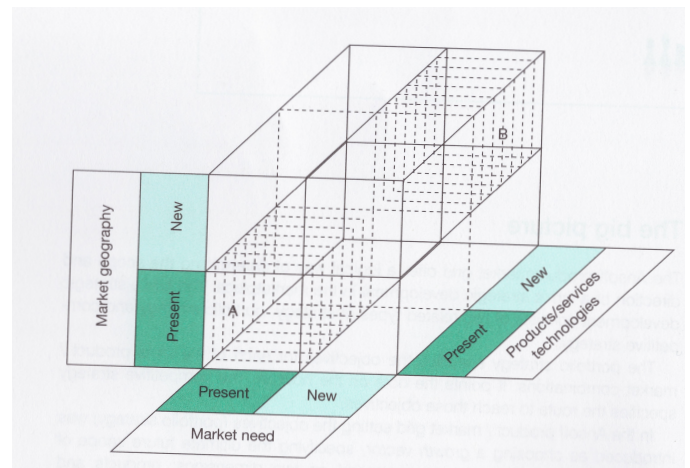
new green products to existing customers. Managers are likely to regard this as challenging, unless customers are dynamic, entrepreneurial and open to change. It would probably be easier to sell products which have undergone modest modification to be greener, rather than radical new green information systems using technology with which customers may not be familiar, such as the Internet of Things or "smart homes". Selling radical new green products such as environmental monitoring systems would probably require the development of new markets and therefore belongs in the *Diversification* quadrant.

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?

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", company culture is frequently hostile to such technologies [25]. Unless there are a number of green champions within the company at a senior level, top managers are likely to favour developing existing markets and making only incremental changes to existing products.

Bilgeri et al. [26] applied the Ansoff Framework to ten companies which were working in the Internet of Things. They found that the companies were most keen on the Product Development strategy. Only one company had a strong focus on Diversification.

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.

Another strand in Ansoff's research on strategic management is presented in [24] and discussed in a modern context in [27]. Ansoff argued that strategic planning was only reasonable when historical trends were developing incrementally, and was not useful when dealing with surprises in an unpredictable environment. In such cases, managers had to respond to "weak signals" in a context of limited information. Ansoff argues that the rational response in such circumstances is to have a flexible strategy and determine which actions will be appropriate when more information becomes available. The signals coming from governments about the need for a more green approach by companies are vague and changeable and are probably perceived by senior managers as "weak". In such circumstances they are likely to postpone radical action.

B. 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 Christensen (discussed above) notes, you cannot analyse a market that does not exist. In particular, companies are likely to worry about finding buyers, where currently there are none. They will also be worried about the difficulty of constructing an efficient supply chain.

C. The BCG Matrix

The Boston Consulting Group Matrix goes back to the 1970s [28] [23]. 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 a successful product could have reasonable expectations of dominating it. Markets for new IT products which are incrementally more energy efficient are likely to be of the fourth type. 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.

D. 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 [29] [23]. It provides an antidote to the problems identified by Christensen, discussed above, where managers tend to avoid disruptive technologies. Two types of blue oceans can be created, either by inventing a new industry or by expanding the strategic boundaries of an existing industry.

Employment of the Blue Ocean model is likely to be positive for the development of new Green IT applications, which potential users were unlikely to have imagined as a possibility, such as the use of the Internet of Things in Western Africa to forecast air quality [30] or the application of blockchain technology in peer-to-peer transactions in photovoltaic power generation [31].

E. 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 [32] [23]. 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.

V. STANDARD MANAGEMENT MODELS FOCUSING ON TACTICS

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

A. Cameron and Quinn's Competing Values Framework

Anthropology takes the view that organizations are cultures; sociology takes the view that organizations have cultures [33]. Most organizational theory adopts the sociological perspective, regarding culture as an attribute of an organization that can be measured and analysed. Schein [34] 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 [35].

Many dimensions of organizational culture have been proposed, for example, Hofstede [36]: 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 [37] [38]. The CVF has been
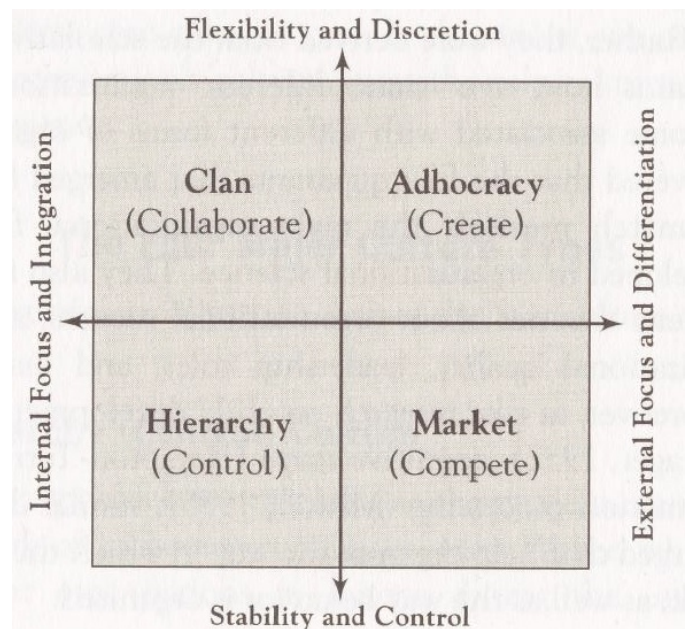

Figure 3. Cameron and Quinn [38]

used in many research studies and has been shown to have a high degree of validity [39].

The four key culture types identified by the CVF are illustrated in Figure 3 and may be summarized as follows (Adapted from [38]):

- 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 CVF has an accompanying Organizational Culture Assessment Tool (OCAI). It 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.

There has been a considerable amount of research on the relationship between types of organizational culture and effectiveness. Richard et al. [40] 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. [41] found a positive link between group (clan) culture and patient and physician satisfaction and also a slight link between balanced cultures and satisfaction.

Linnenluecke and Griffiths [42] used the CVF as a framework for investigating the likely emphases which will be adopted by companies with different types of culture, in pursuing corporate sustainability. They argued that companies would favour initiatives that were congruent with their dominant culture.

The successful adoption and diffusion of green IT systems will also be 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 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 [3] [2]. A statistical analysis of a survey is presented in Sections VIII to XI.

B. 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 [43] [23].

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. Employees are encouraged to change and evolve. Change is emergent.

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

The "Theory O" culture combines elements of the adhocracy and clan cultures of the Competing Values Framework which, it is argued above, are conducive to the adoption of green IT.

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
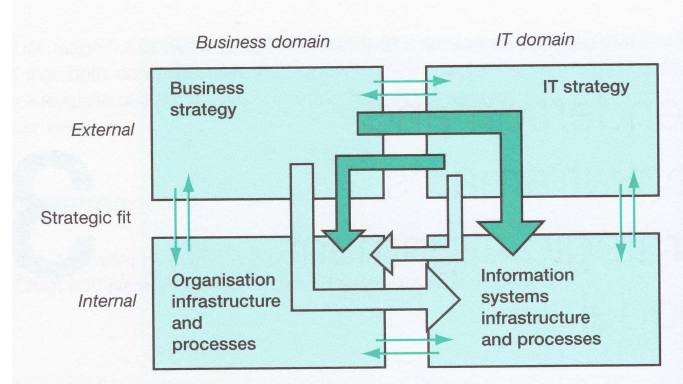

Figure 4. Strategic Alignment Model

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.

C. Henderson and Venkatram's Strategic Alignment Model

This model addresses IT strategy directly. It seeks to promote alignment between business strategy and IT strategy and also between the IT infrastructure and business operations. Research on alignment between business strategy and IT goes back to the late 1980s, when Venkatram and Henderson developed the classic and still highly influential, "Strategic Alignment Model". It is presented in [44], [45] and, slightly amended, in [46]. Coltman et al. [47] describe it as being "on the list of seminal and transformative IS publications". A key feature of this model is that it provides for IT strategy influencing business strategy. Venkatram and Henderson noted that IT had shifted from a traditional back-office, support role towards being an integral part of the strategy of organizations [44].

The model recognises four domains: *Business strategy*, *Organization infrastructure and processes*, *IT strategy*, and *Information Systems infrastructure and processes*. The model is illustrated in Figure 4.

Strategic alignment has two elements: *strategic fit* and *functional integration*. *Strategic fit* refers to alignment between strategy and internal structure and processes, with regard both to business and IT. *Functional integration* refers to alignment between general business matters and IT matters, with regard both to strategy and internal structures and processes.

An important part of the underlying rationale of the model is that there should be cross-domain relationships between the business and IT domains. Four key alignment perspectives are identified. We consider each of them and their relevance to encouraging the adoption of Green IT/Green IS. The alignment perspectives correspond to the arrows in Figure 4.

Strategy Execution

This is visualized by the anti-clockwise arrow from top-left to bottom right in Figure 4. This corresponds to the traditional, hierarchical view of organizations, with business strategy driving organizational infrastructure and information

systems infrastructure and processes. This leaves IT managers in a subordinate role of Business Strategy Implementor. This is unlikely to be favourable to the adoption of green IT, unless the organizational strategy has a strong focus on sustainability.

Technology Transformation

This is visualized by the clockwise arrow from top-left to bottom right. This involves implementing business strategy through IT strategy and then the development of appropriate IT infrastructure and processes. This puts IT managers in the role of Technology Architects. They are in a more influential role than in *Strategy Execution*, because they are not constrained by the current organizational structure. This perspective will be conducive to the adoption of green IT, if there is a green organization strategy.

Competitive Potential

This is called *Technology Exploitation* in [44]. It is represented by the anti-clockwise arrow from top-right to bottom left. This perspective provides for IT strategy influencing organization strategy. A green IT strategy could then drive a change in the organization strategy, which led to changes in the organization infrastructure to reduce the carbon footprint of the organization's use of IT. It could also lead to changes, such as the use of cloud computing services or the development of environmental monitoring systems.

Service Level

This is called *Technology Implementation* in [44]. It is represented by the clockwise arrow from top-right to bottom left. Here the organizational infrastructure follows the IT infrastructure, which is determined by IT strategy. This could be conducive to limited changes to the organizational processes, which reduced the energy consumption of IT within the organization; but not to more fundamental changes such as server virtualisation or the use of the Internet of Things to support environmental sensors, which would need to be driven by business managers at board level.

There is no "right" perspective. Effective strategy development would use all the perspectives as lenses through which to view strategy. Coltman et al. [47] observe that in recent years digital business strategy has effectively become the strategy of many companies, which makes the concept of IT-business strategy alignment less meaningful.

Overall, Henderson and Venkatram's Strategic Alignment Model provides a framework which, if all the perspectives are analysed, should be conducive to the adoption of Green IT.

Loeser et al. [48] extend Henderson and Venkatraman's Strategic Alignment Model to a Strategic Green IT Alignment Framework (SGITAF), which explicitly incorporates Environmental sustainability and Green IT domains. They argue that SGITAF provides a framework which supports the leveraging of Green IT's full potential.

VI. STANDARD MANAGEMENT MODELS FOCUSING ON OPERATIONAL MANAGEMENT

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

The *Change Quadrants* model is a tool to assist companies to effect a particular change [49] [23]. It analyses companies on two dimensions: whether they are "warm" or "cold"; and
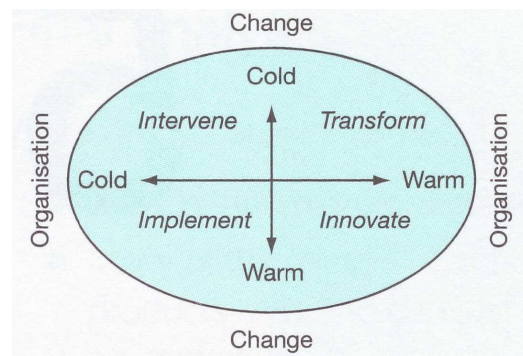

Figure 5. Change Quadrants

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 5. 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. It would be possible to adopt a Deep Green approach to Green IT, in Murugesan and Gangadharan's taxononmy. 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. It would only be possible to adopt a Tactical Incremental approach. 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.

VII. 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.

VIII. STATISTICAL APPLICATIONS OF THE "COMPETING VALUES FRAMEWORK"

Sections VIII to XI present a survey on organizational culture and green IT level, using the "Competing Values
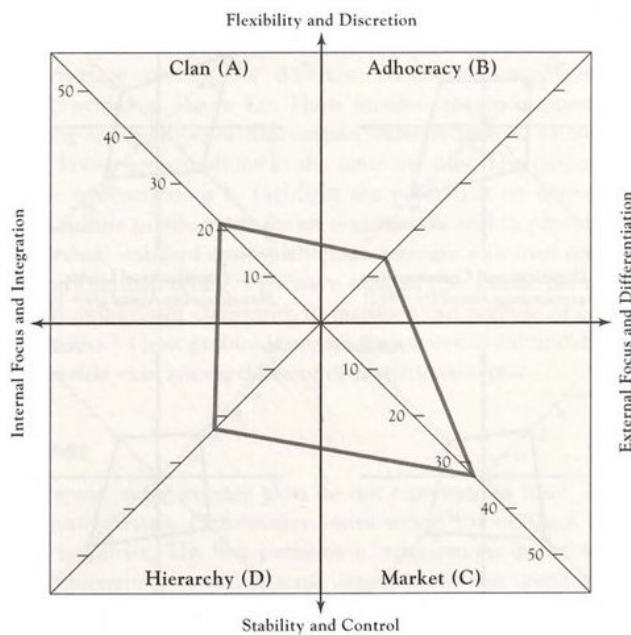
Figure 6. Average Culture Profile [38]

Framework" and seeking to identify significant statistical correlations. It used the OCAI, mentioned above. For each characteristic, people are required to distribute 100 points between statements about company culture, corresponding to the four culture types.

The results can be used for various purposes, e.g, to calculate the average profile of an organization and identify 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 6.

This indicates that companies tend, on average, to be dominated by market and hierarchy cultures. Cameron and Quinn also found a tendency for companies to drift towards a greater emphasis on market and hierarchy as they matured. Both of these factors suggest a tendency for corporate culture to be inimical to sustainability initiatives.

Some researchers use a Likert version of the OCAI. The implications of this are discussed later.

All of the example uses of the CVF mentioned in earlier sections use statistical analysis, with the exception of Linnenluecke and Griffiths [42]. There have been many other statistical applications of the OCAI to investigate the relationship between culture and various factors. Business Process Management is considered in [50]; Knowledge Management is considered in [51].

IX. RESEARCH METHODOLOGY

In this section, we state the research questions and outline the design and execution of the survey which was undertaken.

A. Research Questions

The key research questions are:

- Does organizational culture have an impact on the adoption of green IT within companies?
- Is the impact, if any, which organizational culture has on the adoption of green IT, affected by the country in which the company is located?

The following then are the research hypotheses:

H1Null The organizational culture type has no effect on the adoption of green IT.

H1Positive The organizational culture type has a significant effect on the adoption of green IT.

H2Null The impact of organizational culture on the adoption of green IT is not affected by the country in which a company is located.

H2Positive The impact of organizational culture on the adoption of green IT is significantly affected by the country in which a company is located.

B. Survey Design

A survey was used to evaluate the organizational culture of companies and the extent to which they had adopted measures to support the adoption of green IT.

Cameron and Quinn's "Competing Values Framework" provided the theoretical underpinnings of the culture test. The associated OCAI tool was employed.

The level of greenness in the deployment of IT in the respondent's company was measured by eight questions, covering policy, strategy and practical issues, such as whether the company purchased computers with silver or gold EPEAT ratings. One question, on whether the company had a Green IT Policy in place, had possible answers yes/no/don't know. The remaining questions required responses to statements about greenness on a 5 point Likert scale, from "Strongly Agree" to "Strongly Disagree".

In addition, there were questions about demographics, asking the respondent to identify the country in which they were located, the industry sector of their company, the size of the company and their primary role in the company.

C. Survey Execution

The survey was created using Qualtrics. It was distributed electronically to contacts of the authors for onward distribution and placed on a number of forums.

The preamble to the survey included the statement: "This survey is intended to be completed by people, for whom IT (widely defined) forms a substantial part of their job function."

X. RESULTS AND ANALYSIS

A. Demographics

There were 29 usable replies, from a range of countries as shown in Figure 7.

The highest categories for Industry Sector were Education (16) and IT. The remaining respondents came from a range of areas, including government, banking and transport.

7 respondents identified their primary roles as IT Managers; 3 as Chief Information Officers. Over one third of respondents chose the "Other" box, giving a wide range of roles.

Country	Freq	%
India	3	10.3
UK	9	31.0
US	1	3.4
France	12	41.4
China	3	10.3
Russia	1	3.4
Total	29	100.0

Figure 7. Location

Culture	Cronbach's Alpha Based on Standardized Items
Clan	0.852
Market	0.817
Adhocracy	0.773
Hierarchy	0.829
Green IT Measure	0.888

Figure 8. Cronbach's Alpha

	Minimum	Maximum	Mean	Std. Deviation
ClanTotal	0.50	80.00	25.6609	17.28918
MarketTotal	0.00	55.00	26.8333	15.58948
AdhocTotal	0.00	33.33	17.5115	9.16125
HierTotal	6.67	75.00	29.9943	17.40630

Figure 9. Culture Statistics
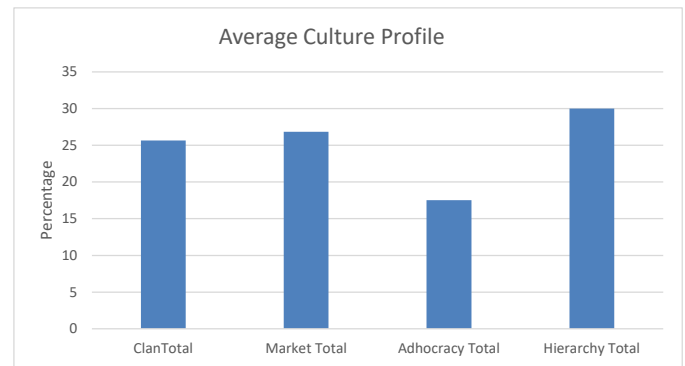
Figure 10. Culture Profile

Pearson Correlations		
		Level of Green IT
ClanTotal	Pearson Correlation	-.369[*]
	Sig. (2-tailed)	0.049
	N	29
MarketTotal	Pearson Correlation	0.151
	Sig. (2-tailed)	0.433
	N	29
AdhocTotal	Pearson Correlation	-.431[*]
	Sig. (2-tailed)	0.020
	N	29
HierTotal	Pearson Correlation	.458[*]
	Sig. (2-tailed)	0.012
	N	29

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Figure 11

B. Reliability

We used Cronbach's Alpha measure, based on standardized items, to test reliability. Each of the six questions in the OCAI represents a test of culture, with the first option of the questions corresponding to clan culture, the second to adhocracy culture, the third to market culture and the fourth to hierarchy culture. We measured for consistency across these six questions.

Four of the questions used to measure the level of adoption of green IT required respondents to score on a five point scale. We tested for consistency across these questions.

The results are given in Figure 8. All variables met the generally recognised benchmark of being at least 0.75. It is noticeable that the score for adhocracy is significantly lower than the other culture types. This may be because this culture type is more nebulous and harder to recognise and characterize.

C. The Impact of Organizational Culture

Figures 9 and 10 give the average culture profile of the sample. It is consistent with the research of Cameron and Quinn mentioned above, with market and hierarchy being the dominant cultures. However, in Cameron and Quinn's research, market culture takes first place, whereas in the present study, hierarchy takes first place. The lower market value may reflect the relatively high proportion of people working in education.

Figure 11 applies Pearson Correlation to the four culture types with the level of Green IT in the organization. The Green IT measure has 1 as the highest level of Green IT and 5 as the lowest. Hence a negative value of the Pearson correlation coefficient indicates that a culture type is positively associated with greenness. We do not know in advance whether particular culture types will have a positive or negative influence, so we used 2-tailed correlation.

Clan and adhocracy cultures are positively associated with greenness and hierarchy culture is negatively associated. These correlations are at the 0.05 level. The smallness of the sample made it unlikely that an association at the 0.01 level would be found. No significant assocation was found for market culture.

We can therefore reject the H1Null hypothesis above and conclude that culture has an effect on the adoption of green IT.

D. The Impact of Location

Figure 12 gives the culture profile for the UK and France, which were the only countries to have a significant number of

		Minimum	Maximum	Mean	Std. Deviation
UK	ClanTotal	4.2	38.3	22.1	11.7
	MarketTotal	0.0	48.3	23.9	14.3
	AdhocTotal	4.2	33.3	19.5	10.3
	HierTotal	18.3	75.0	34.4	23.1
France	ClanTotal	10.8	80.0	34.0	21.7
	MarketTotal	5.8	50.0	26.3	17.8
	AdhocTotal	4.0	25.0	15.1	6.2
	HierTotal	6.7	48.3	24.7	14.0

Figure 12. Culture Profile by Country

			Green IT Level
UK	ClanTotal	Pearson Correlation	-0.526
		Sig. (2-tailed)	0.146
		N	9
	MarketTotal	Pearson Correlation	-0.299
		Sig. (2-tailed)	0.435
		N	9
	AdhocTotal	Pearson Correlation	-0.650
		Sig. (2-tailed)	0.058
		N	9
	HierTotal	Pearson Correlation	.742*
		Sig. (2-tailed)	0.022
		N	9
France	ClanTotal	Pearson Correlation	-0.094
		Sig. (2-tailed)	0.771
		N	12
	MarketTotal	Pearson Correlation	0.251
		Sig. (2-tailed)	0.432
		N	12
	AdhocTotal	Pearson Correlation	0.135
		Sig. (2-tailed)	0.676
		N	12
	HierTotal	Pearson Correlation	-0.233
		Sig. (2-tailed)	0.465
		N	12

Figure 13. Pearson Correlation for France and the UK

respondents. It is noticeable that the UK has a substantially lower clan and higher hierarchy score than France. This may reflect the collegiate nature of French universities, but the small number of the sample makes it impossible to draw firm conclusions.

Figure 13 gives Pearson correlations for France and the UK. The only statistically significant correlation (at the 0.05 level), between culture and greenness, for either the UK or France, was that for the UK, hierarchy culture has a negative impact on greenness. We therefore cannot reach a conclusion on the validity of the H2 hypotheses.

XI. Discussion

The literature generally indicates that clan and adhocracy cultures are positively correlated and hierarchy cultures negatively correlated, with characteristics that require openness to new practices, such as concern for green issues. Examples include [52], [53] and [50] (with regard to clan and hierarchy culture). The present study is consistent with this.

The CVF has been used in many research studies and has been shown to have a high degree of validity. Cameron and Freeman [54] and Zammuuto and Krakower [55] applied it in the field of higher education and found that culture type was a strong predictor of organizational effectiveness. These studies found evidence for concurrent validity. Quinn and Spreitzer [39] further found evidence for convergent validity and discriminant validity. However, the findings of the meta-analytic investigation of the CVF by Hartnell et al. [56], while supporting the contention that culture has a major impact on organizational effectiveness, provided only mixed support for the CVF's underlying suppositions.

There is a Likert version of the OCAI, which was used in some of the studies using the CVF, for example [51], [53] and [57]. The ipsative version forces people to make choices: giving a high score to one culture type reduces the points available for other types. With the Likert version by contrast, it is possible to give a high score to all culture types. In [57], it was found that all four culture types were positively correlated with successful use of knowledge management practices. This result would have been unlikely if the ipsative version of the OCAI had been used.

Eijnatten et al. [58] provide an interesting and extremely detailed analysis of the difference between ipsative and Likert surveys, with particular reference to the CVF. They argue that Likert surveys are norm-referenced, whereas ipsative studies are criterion referenced. For example, in an ipsative survey, a respondent might give a low score for adhocracy because they had given a high score to other culture types. Another respondent in a different company might allocate a higher score to a company with the same adhocracy characteristics, making it invalid to compare scores. Eijnatten et al. further contend that with ipsative studies only "only intra-individual, not inter-individual, comparisons are possible." This would make traditional correlation techniques invalid. Eijnatten et al. propose alternative statistical analysis techniques, involving the use of Fisher's permutation test and Aitchison distances.

Eijnatten et al. note that completing ipsative questions is more difficult that completing Likert ones, resulting in lower response rates.

It is noticeable that all the correlation coefficients for France are low, suggesting that the results of the survey are somewhat random. This may reflect the fact that the OCAI survey is linguistically quite challenging, especially for speakers of English as a second language. Or it may reflect the fact that the survey is rather rooted in the Anglo Saxon, especially US world, with its references to concepts such as "nurturing leadership".

The key weakness of this study is the small sample size. It is challenging to ensure that a survey is completed by a sample that is sufficiently large and representative to permit statistical analysis to be undertaken with a high degree of confidence. It may be worth exploring the use of web crawling to look for indications of culture and assess level of consideration of green issues.

There needs to be greater consideration of the international dimension. However, using Cameron and Quinn's Organizational Culture Assessment Instrument in an international set-

ting raises complex issues. The Competing Values Framework is located within the Anglo-American business tradition and there is a deep link between culture and language. Outside the English-speaking world, the OCAI either has to be translated or be completed by respondents using a second language. Both approaches make transnational comparison difficult.

XII. 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.

This paper has investigated the impact of culture, in particular organizational culture, on the success of green IT initiatives.

An international survey was undertaken on organizational culture and green IT level. The key finding is that culture has a major impact on the success of sustainability initiatives within ICT, with clan and adhocracy cultures being positively associated and hierarchy cultures negatively associated with greenness. Managers introducing sustainability initiatives must seek to understand the culture within their organization. They could seek to encourage a clan culture, for example, by using 360 degree performance evaluation where, in addition to being assessed by their managers, staff assess their managers and peers.

An investigation was also undertaken into whether the impact, if any, which organizational culture has on the adoption of green IT, is affected by the country in which the company is located. The results were inconclusive.

There was discussion of the complex technical issues which arise from the statistical analysis of culture surveys.

Future research directions include further 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.

REFERENCES

[1] W. M. Campbell, "An exploration of the use of standard management models on the adoption of Green IT," in Proceedings of Green 2017: The second International Conference on Green Communications Computing and Technologies.

[2] W. M. Campbell, M. Ratcliffe, and P. Moore, "An exploration of the impact of organizational culture on the adoption of green IT," in Proceedings of the Green Computing and Communications Conference (Green-com), 2013, pp. 68–76.

[3] W. M. Campbell, M. Ratcliffe, P. Moore, and M. Sharma, "The influence of culture on the adoption of green IT," in Green Services Engineering,Optimization and Modeling in the Information Age, X. Liu and Y. Li, Eds. Earthscan, London, 2015, pp. 25–60.

[4] L. Belkhir and A. Elmeligi, "Assessing ICT global emissions footprint:trends to 2040 and recommendations," Journal of Cleaner Production, 2018.

[5] M. Menguc and L. Ozanne, "Challenges of the green imperative: a natural resource-based approach to the environmental-business performance relationship," Journal of Business Research, vol. 58, 2005, pp. 430–438.

[6] J. Elkington, "Towards the sustainable corporation." California Management Review, vol. Winter, 1994, pp. 90–100.

[7] ——, "Enter the triple bottom line," in The Triple Bottom Line: Does It All Add up?, A. Henriques and J. Richardson, Eds. Earthscan, London, 2004, pp. 1–16.

[8] W. E. Stead and J. G. Stead, Management for a small planet: Strategic decision making and the environment. Newberry Park, CA: Sage, 1992.

[9] J. E. Post and B. W. Altman, "Managing the environmental change process: Barriers and opportunities," Journal of Organizational Change Management, vol. 7, no. 4, 1994, pp. 64–81.

[10] G. H. Brundtland, "Our common future," in Report of the World Commission on Environment and Development. Oxford University Press, 1987.

[11] U. Nations, "Paris agreement," in Framework Convention on Climate Change. United Nations, 2016.

[12] T. Jenkin, J. Webster, and L. McShane, "An agenda for 'green' information technology and systems research," Information and Organization, vol. 21, 2011, pp. 17–140.

[13] R. T. Watson, M. C. Boudreau, A. Chen, and M. H. Huber, "Green IS: Building sustainable business practices," in Information Systems. Athens, GA, USA: Global Text Project, 2008.

[14] V. Dao, I. Langella, and J. Carbo, "From green to sustainability: Information technology and an integrated sustainability framework," Journal of Strategic Information Systems, vol. 20, 2011, pp. 63–79.

[15] DeutscheBank, "Green IT: Energy efficiency at work," https://www.db.com/cr/en/concrete-green-it.htm, Accessed 14 August 2018.

[16] A. Bokolo, M. Majid, and A. Romli, "Organizational culture and leadership: Preconditions for the development of a sustainable corporation," Sustainable and Applied Information Technology, vol. 95, no. 9, 2017, pp. 1875–1915.

[17] S. Murugesan and G. R. Gagadharan, Eds., Harnessing Green IT: Principles and Practices. Wiley, 2012.

[18] A. Molla and V. Cooper, "Enterprise Green IT readiness," in Harnessing Green IT: Principles and Practices, S. Murugesan and G. R. Gagadharan, Eds. Wiley, 2012.

[19] Q. Deng and S. Ji, "Organizational Green IT adoption: Concept and evidence," Sustainability, vol. 7, 2015.

[20] B. Wernenfelt, "A resource based view of the firm," Strategic Management Journal, vol. 5, 1984, pp. 171–180.

[21] S. L. Hart, "A natural-resource based view of the firm," Academy of Management Review, vol. 20, no. 4, 1995.

[22] FinancialTimes, "Where did FT500 chief executives go to business school?" https://www.ft.com/content/3a63c054-b885-11e5-b151-8e15c9a029fb, Accessed 3 June 2019, Published January 2016.

[23] M. VanAssen, Key Management Models: The 60+ models every manager needs to know. Prentice Hall, 2009.

[24] H. I. Ansoff, Corporate Strategy. Penguin Books, 1987.

[25] C. Christensen, The Innovator's Dilemma: Whe New Technologies Cause Great Firms to Fail. Harvard Business Review Press, 1997.

[26] D. Bilgeri, E. Fleisch, and F. Wortmann, "How the IoT affects multibusiness industrial companies: IoT organizational archetypes," in Proceedings of the Thirty Ninth Conference on Information Systems, San Francisco 2018.

[27] M. Holopainen and M. Toivonen, "Weak signals: Ansoff today," Future, Elsevier, vol. 44, 2012, pp. 198–205.

[28] D. C. Hambrick, I. C. Macmillan, and D. L. Day, "Strategic attributes and performance in the BCG matrix," Academy of Management Journal, vol. 25, 1982, pp. 510–531.

[29] W. C. Kim and R. Mauborgne, Blue Ocean Strategy. Harvard Business School Press, 2005.

[30] C. Dupont, M. Vecchio, C. Pham, B. Diop, C. Dupont, and S. Koffi, "An open IOT platform to promote eco-sustainable innovation in Western Africa: Real urban and rural testbeds," Wireless Communications and Mobile Computing, 2018.

[31] C. Gao, Y. Ji, J. Wang, and X. Sai, "Application of blockchain technology in peer-to-peer transaction of photovotaic power generation," in 2nd IEEE Advanced Information Management, Communications, Electronic and Automation Control Conference, 2018.

[32] J. Kay, Foundations of Corporate Success: How business strategies add value. Oxford University Press, 1993.

[33] K. Cameron and D. R. Ettington, "The conceptual foundations of organizational culture," in Higher Education: Handbook of Theory and Research, J. C. Smart, Ed. Norwell, Mass.: Kluwer, 1988, vol. 4.

[34] E. Schein, Organizational Culture and Leadership. Jossey-Bass, 1992.

[35] K. Cameron, D. Bright, and A. Caza, "Exploring the relationship between organizational virtuousness and performance," American Behavioral Scientist, vol. 47, 2004, pp. 766–790.

[36] G. Hofstede, Culture's Consequences. SAGE, 1980.

[37] R. Quinn and J. Rohrbaugh, "A spatial model of effectiveness criteria: Toward a competing values approach to organizational analysis," Management Science, vol. 29, 1983.

[38] K. Cameron and R. Quinn, Diagnosing and Changing Organizational Culture Based on the Competing Values Framework. Wiley, 2011.

[39] R. Quinn and G. Spreitzer, "The psychometrics of the competing values culture instrument and an analysis of the impact of organizational culture on quality of life," in Research in Organizational Change and Development, R. W. Woodman and W. A. Passmore, Eds. Greenwich Conn.: JAI Press, 1991, vol. 5.

[40] O. Richard, A. McMillan-Capehart, S. N. Bhuian, and E. C. Taylor, "Antecedents and consequences of psychological contracts: Does organizational culture really matter?" Journal of Business Research, vol. 62, 2009, pp. 818–825.

[41] B. T. Gregory, S. G. Harris, A. A. Armenakis, and C. L. Shook, "Organizational culture and effectiveness: A study of values, attitudes and organizational outcomes," Journal of Business Research, vol. 62, 2009, pp. 673–679.

[42] M. Linnenluecke and A. Griffiths, "Corporate sustainability and organizational culture," Journal of World Business, vol. 45, 2010, pp. 357–366.

[43] M. Beer and N. Nohria, Breaking the Code of Change. Harvard Business School Press, 2000.

[44] J. C. Henderson and N. Venkatram, "Strategic alignment: A model for organizational transformation via Information Technology," Publication of Centre for Information Research, Sloan School of Management Massuchusetts Institute of Technology, 1990.

[45] ——, "Understanding strategic alignment," Business Quarterly, vol. 55, no. 3, 1991, pp. 12–89.

[46] ——, "Strategic alignment: Leveraging information technology for transforming organizations," IBM Systems Journal, vol. 32, no. 1, 1993, pp. 4–16.

[47] T. Coltman, P. Tallon, R. Sharma, and M. Queiroz, "Strategic alignment: twenty-five years on," Journal of Information Technology, vol. 30, 2015, pp. 91–100.

[48] F. Loeser, K. Erek, N.-H. Schmidt, R. Zarenkow, and L. M. Kolbe, "Aligning Green IT with environmental strategies: Development of a conceptual framework that leverages sustainability and firm competitiveness," in AMCIS 2011 Proceedings.

[49] J. P. Cotter, Breaking the Code of Change. A Force for Change: How Leadership differs from Management, 1990.

[50] B. Hribar and J. Mendling, "The correlation of organizational culture and and success of BPM adoption," in Proceedings of the Twenty Second European Conference on Information Systems, Tel Aviv 2014.

[51] C. Chin-Loy and B. G. Mujtaba, "The influence of organizational culture on the success of knowledge management practice with North American companies," International Business and Economics Research Journal, 2007.

[52] Ülle Übius and R. Alas, "Organizational culture types as predictors of corporate social responsibilty," ISSN 1392-2785 Engineering Economics, vol. 1, no. 61, 2009.

[53] A. Akano and W. M. Campbell, "A Cross-cultural Survey of the Impact of Organizational Culture on Adoption of Green IT," in Proceedings of the Eighth International Conference on Complex, Intelligent and Software Intensive Systems 2014 (CISIS 2014). Birmingham UK, 2014.

[54] K. Cameron and S. Freeman, "Cultural congruence, strength and type: Relationships to effectiveness," in Research in Organizational Change and Development, R. W. Woodman and W. A. Passmore, Eds. Greenwich Conn.: JAI Press, 1991, vol. 5.

[55] R. F. Zammuto and J. Y. Krakower, "Quantitative and qualitative studies of organizational culture," in Research in Organizational Change and Development, R. W. Woodman and W. A. Passmore, Eds. Greenwich Conn.: JAI Press, 1991, vol. 5.

[56] C. A. Hartnell, A. Y. Ou, and A. Kinicki, "Organizational culture and organizational effectiveness: A meta-analytic investigation of the competing values framework's theoretical suppositions," Journal of Applied Psychology, vol. 96, no. 4, 2011, pp. 677–694.

[57] K. Chidambaranathan and S. BS, "Analysing the relationship between organizational culture and knowledge management dimensions in higher education libraries," Journal of Librarianship and Information Science, 2017.

[58] F. M. Eijnatten, L. van der Ark, and S. S. Holloway, "Ipsative measurement and the analysis of organizational values: an alternative approach for data analysis," Quality and Quantity, vol. 49, 2015.