

Sustainability in Information Systems: Requirements and Emerging Technologies

Marcel Korte, Kevin Lee, Chun Che Fung

School of Information Technology, Murdoch University, Murdoch 6150, Australia

{m.korte, kevin.lee, l.fung}@murdoch.edu.au

Abstract—Despite the ever increasing pervasion of information systems in business processes the industry lacks a focus on sustainability. While concepts of sustainability have been applied to many other areas, Information Systems (IS) is yet to demonstrate a balanced economic, ecological and social focus. This paper discusses the issues of IS sustainability and the implications for strategic IS management. It analyses the major stakeholder businesses that the Information and Communications (ICT) industry deal with and identifies requirements for successful sustainable IS management. It also discusses current emerging technologies in the field of ICT and their potential for supporting sustainable IS management. Bringing these ideas together will extend the ongoing discussion of ICT's environmental impact by providing Chief Information Officers, IS and environmental managers and researchers alike with a conceptual foundation towards future sustainable information systems management.

Index Terms—IS management, Sustainability, Green IT, Strategic Management

I. INTRODUCTION

Sustainability is concisely defined by the Brundtland Commission of the United Nations [1] as economic, social and environmental development meeting the needs of today without compromising the ability of future generations to meet their own needs. This was further refined at the UN World Summit in 2005 [2]. Practitioners and researchers recognize widely sustainability as a long-term concept of economical, ecological and social optimisation. Expanding the long established financially focused reporting by the two latter dimensions sustainability requires accounting for the triple bottom line (TBL) - people, planet, profit [3], [4].

ICT is a significant and growing part of the environmental problem. Its carbon footprint is estimated to account for 2 to 3 percent of global carbon dioxide emissions - approximately as much as the aviation industry [5], [6]. With the ICT industries ongoing growth and increasing impact on economy, ecology and society, it is increasingly challenged to take sustainable management into account [7]. Yet the environmental burden is only one side of the ecologic information technology complex; information technology also offers potential benefits. The use of IS is projected to eliminate 7.8 metric gigatons of greenhouse gasses annually by 2020, five times as much as the industries emissions [8]. Sustainable IS offers multiple options to reduce the environmental burden other business processes create and therefore indirectly contribute to the reduction of GHGs and other environmental concerns. IS will be a major element in the transition to a sustainable economy [9], yet the role of IS as both a contributor and a solution provider

to ecological sustainability by supporting corporate green strategies is receiving only limited research focus [10].

IS has the transforming power to create a environmentally sustainable society [11]. Although the theoretical foundations to support the concept of sustainable IS remains unclear. Although the ideas of green IT and sustainable IS have become commonly used [12] the requirements leading towards successful sustainable IS management have been scarcely researched. Currently emerging technologies are likely to accelerate the drive towards increased sustainability. There is therefore a need for increased research in the area of sustainability in information systems management.

This paper focusses on highlighting sustainability issues for medium to large businesses and multinational corporations in the developed world. In particular it looks at enterprises that are part of the ICT industry. It aims to analyse transformation in high-level IS management to aid board members, senior IS managers or senior environmental managers. It also aims to encourage debate and raise interest in the academic community in this scarcely researched but important area.

The remainder of this paper is structured as follows. Section II presents some background on corporate sustainability and strategic IS management. Section III discusses sustainable IS management, focusing on stakeholder identification and the requirements for sustainable information systems management. Section IV discusses currently emerging technologies under the objective of their contribution towards sustainable IS. Finally, Section V presents some conclusions.

II. BACKGROUND

As argued in the introduction, there is a need for a push towards sustainability as a major focus in the management of Information Systems. This section provides background on emerging area of corporate sustainability and strategic IS management.

A. Corporate Sustainability

While it is clear that the purpose of a company is to create value, the questions of what sort of value, for whom and how are widely argued. This has led to the increased popularity of the shareholder value concept [13]. The shareholder value approach is still widely used today and focuses in the surplus funds available for distribution to the shareholders. It therefore only accounts for the economical dimension of corporate performance. Corporate sustainability captures a

broader spectrum of values by balancing economic, social and environmental performance as key strategic issues. Accounting for these three dimensions - the triple bottom line (TBL) - demands that business focus on more than just maximizing shareholder value - taking into account other stakeholders.

B. Strategic IS Management

A study of 179 large U.S. firms shows that sustainability strategies are typically top-down [14]. The most effective sustainability strategies are those when top management is clearly committed to the strategy. Environmental performance is significantly related to financial performance, businesses that don't develop strategies to evaluate their social and environmental impact miss out on potential earnings growth. Further corporate risks involve future consequences such as increased cost, increased community concerns, increased legal claims, and damaged corporate reputation [4]. Mitigating these issues requires an integrated concept of sustainability and an alignment of IS strategy to corporate strategy.

C. Summary

This section has highlighted a range of important issues which must be tackled in order to promote sustainability in the management of Information Systems, summarised as follows.

- The need for stakeholder identification and engagement businesses of the ICT industry.
- The need for sustainability focus in IS management and the consequential requirements.
- The need for theoretical foundations to support the concept of sustainable IS.
- The need for analysis of emerging opportunities in IS to create business advantage.

The following sections discuss these issues and potential solutions in more detail.

III. SUSTAINABLE IS MANAGEMENT

This section investigates sustainability in the context of IS management. Section III-A analyses the stakeholders of a selection of leading ICT companies and Section III-B discusses the resulting requirements for IS management.

A. Stakeholders

The largest global technology companies - as defined by turnover in 2009 [15] - share a similar view of their stakeholders. By analysing the latest published sustainability reports of Samsung Electronics, HP, Hitachi, IBM, Sony, Toshiba, Panasonic, Dell, Foxconn and Nokia a homogeneous list of stakeholders for this size of organisations can be created. An ever growing number of stakeholders are requiring these organisations to explain and justify their sustainability strategy and performance. These growing pressures are dramatically influencing organisations as individual stakeholders seek to impose their particular focused interest on the business practice at all levels. These stakeholders play a major role in an organisation e.g. determining what projects will get financed, how products perform in the market and whether

valuable employees stay with the organisation and therefore influence sustainability policy. How an organisation defines its stakeholders will determine their involvement in the decision-making process as well as how stakeholder reactions will be managed. The following attempts to categorise the impact of the analysed organisations stakeholders within the five core categories as coined by Esty [9].

Rulemakers and Watchdogs

Non-Governmental Organisations. Some 40,000 multinational NGO's [16] are estimated to exist and many more are based in single countries. These range from large such as Greenpeace, the World Wildlife Fund and Sierra Club to less structured, local movements involving small groups of individuals. Many long-term established NGOs have moved from confrontation and agitation towards sophisticated partnerships and political campaigning. Others focus on activist campaigning and provocation. It is difficult to deal with all NGO interests, but organisations without a strategy to deal with NGOs run the risk of being targeted as prominently happened to Shell when planning to sink Brent Spar [17].

Governments. The environmental legislature is highly dynamic and complex, dependent on the policies of current governments from multi-national level (e.g. EU) down to regional and local laws. Businesses that do not track legislative change and act proactively run risk of competitive disadvantage. Corporations face the challenge of finding the right balance between international and national laws along side their ethical and social obligations. Implementing directives more efficiently than their industry peers offers business advantages.

Regulators. Organisations have to abide by the directives of industry regulators who ensure fairness in the market. Environmental regulators ensure that organisations abide by industry rules e.g. waste products from industrial processes are disposed of correctly. This is particularly common in the European market e.g. to deregulate former public sectors regulators are less affected by sudden political change.

Employees, Consumers and Communities

Employees. Employees represent the most complex of all stakeholders and can be the most important of all stakeholders because of their complexity as well as their multilevel influence on the corporate sustainability strategy. They provide the knowledge to transform the business and determine the success or fail of any sustainability initiative. In an ICT labour market with increased insufficiency of highly-skilled workers, employees' demands are shifting towards more eco-friendliness and social-responsibility and a willingness to lower their economic expectations to realize these goals [18]. This shift can offer business positives such as reduced HR churn, improved workforce commitment and improved productivity [19].

Consumers. The consumer market of the ICT industry has been mainly driven by continuous product improvement and innovation. Sustainability issues are not generally transparent as they are a secondary interest to the ICT consumer. Other, more saturated and less innovative markets show increased business potential for more eco-friendly and socio-friendly products, for example, the US market for organic, fair trade,

food and consumer products offers higher profitability than its traditional correspondent. With the deregulation of the electricity markets, especially in Europe, an increasing number of consumers choose electricity from renewable resources for higher cost. Similar trends can be expected in the long run in the ICT sector. Leading companies are increasingly seeking to improve their green image with reducing toxic chemicals, increased recycling and reduced packaging of their products.

Communities. Industries, especially the primary resource sector, have heavily invested in communication with communities when developing new mines, oil and gas fields, erecting chemical plants or power plants because of the realisation that they are a powerful stakeholder. The lower impact on communities from the ICT sector means it is less likely to face such challenges. All organisations rely on the social infrastructure of the communities they are active in and these demand corporate citizenship in return. Rethinking their societal responsibility organisations use a range of instruments ranging from social sponsoring to corporate foundations to social lobbying in response to satisfy this demand.

Investors and Risk Assessors

Shareholders and Other Investors. These are very heterogeneous, with each shareholder or investor having individual interests beyond short-term corporate profits. Increasingly, institutional investors analyse companies for sustainability factors. Social investment funds, green investment funds and faith-based investment funds have increasing market weight. Shareholders may also use their shareholder resolutions to demand change towards more sustainable business practice.

Industry analysts. Corporate sustainability is not just about eco-friendliness and good citizenship but also critically the bottom-line shows the interest of analysts in sustainability benchmarks. The Dow Jones Sustainability Index and its European counterpart the FTSE4Good steer investors to superior performers. More than 3,000 companies disclosed their carbon emissions in 2010 to the Carbon Disclosure Project which itself acts on behalf of 551 institutional investors holding US\$71 trillion in assets under management.

Idea Generators and Opinion Leaders

Universities. Academic institutions are valuable stakeholders in the ICT industry as they provide new ideas and knowledge in all fields of business operation and strategy. Because of the high demand for skilled workers close relationships to institutions of higher learning provide valuable opportunities to connect with future talented people.

Media. Media investigation and reaction to sustainability issues drive public awareness and understanding. With the change from traditional media to Internet-based media, social media and social networking, organisations today face a large amount of news sources shaping the public opinion. Interest groups can use the opportunities of the modern media as an efficient way to spread their opinions around the connected global society. As with other stakeholders, the media is not just a threat to organisations but also offers new opportunities. Internal blogs, forums and websites allow the organisation to get a better picture of their employees

opinions about products, policies and actions. Monitoring and managing the public action and opinion of the whole product lifecycle from suppliers to recycling or disposal more efficiently than competitors also offers business advantages.

Business Partners and Competitors

Suppliers. To guarantee that products and services fulfill a businesses standards buyers insist on their suppliers meeting regulations and standards. Compliance with these need to be monitored and managed. Social responsibility needs to be managed throughout the whole product lifecycle.

Business Partners. Businesses deal with multiple other stakeholders such as industry associations, competitors and workers unions. Industry associations set standards and shape their industry's reputation while competitors can make such reputable change leading to de-facto standards and guideline such as Walmart's Sustainable Product Index.

Without stakeholder engagement and feedback, management becomes shortsighted in its strategic focusing and narrow-minded in its business operations. Better sustainable focused businesses gain strategic advantage by reacting to the pressures their stakeholders impose and manage their stakeholder relationships proactively. To efficiently deal with stakeholder pressures there is a need to understand these pressures being applied on and within an organisation at different levels on each organisational unit; although all stakeholders apply some pressure on every organisational unit. While the global ICT industry is growing at a high speed it is perceived as having both negative and positive impact on the environment [20], the management of the opportunities and threads deriving from the above mentioned pressures in relation to information systems deserve more attention to detail.

The CIO in their role as the highest ranking IT/IS executive is a key figure with respect to sustainable IS management. Positioned not more than two levels from the CEO they are in close communication with the leading management. The CIOs core function is the management of the information resource, the governing of the organisational strategy and the strategic planning of IT/IS. As Lane [21] notices, the CIO obligations become increasingly business focused and strategic and as the role of IS has grown in importance, so has the CIO's [22].

B. Requirements for Sustainable Information Systems Management

The following section represents a list of requirements for the CIO and top IS management to drive the transformation towards improved sustainability and business advantage through superior sustainability performance in the future.

- *Leadership: IS sustainability as a top-level corporate issue.* Businesses' overall goals and orientation are articulated in their mission statement, a formal framework within which the company's strategies are developed. As corporate sustainability II-A effects the whole organisation, the CEO and board need to set the tone towards sustainability as part of their mission statement. It is vital for them to be responsible for initiating, communicating and implementing sustainability [23].

- *Strategy: IS sustainability as a new focus in strategic IS management.* The development of a strong corporate sustainability strategy is critical to changing the corporate culture, reducing potential resistance and ensuring success in the transforming process. Recognizing that long-term economic growth must be socially and environmentally sustainable CIOs have to reassess their focus. Green IT focuses mainly on regulatory compliance (hazardous materials, waste reduction, etc.) and cost minimization (s.a. energy efficiency). Integration of all three dimensions of sustainability, economic, environmental and social, has to be the result of this change in strategy.
- *Organisation: IS sustainability changing the organisation.* As practitioners and academics agree on the need for organisational alignment, the changes in IS strategy lead to changes within the organisation. The quality and extent of change is highly dependent on the existing structure. IS in form of Environmental Management Systems and tools for collaboration can be a solution to this problem.
- *Costing: IS sustainability expanding the costing focus.* Economical focused strategic decision making process gives little attention to social and environmental issues. Progressing towards an integrated sustainability strategy the CIO needs to cater for these dimensions. While the immediate perception is that of increasing cost, benefits such as shareholder value added or reduced regulatory risk offset short term investments. New products, processes and services will need to be additionally assessed against social and environmental aspects just like they are today being assessed against economic parameters.
- *Evaluation: IS sustainability expanding performance measurement.* Performance measurement systems are widely used in the ICT industry but lack sustainability performance components. By defining and measuring additional social and environmental KPIs and work goals IS management are able to collect tangible information to include in each stage of the strategic management process. Sustainable performance measurement is required for successful management within the IS domain.
- *Reporting: IS sustainability in the focus.* It is critical to collect and analyze information on sustainability. External stakeholders such as the media, communities and risk assessors explicitly demand information on sustainability performance. To address this demand an increasing number of businesses regularly publish sustainability reports. To support the continuous improvement of sustainability the CIO needs to ensure communication of performance data within his domain as well as across the business.
- *Benchmarking: IS sustainability in need of external evaluation.* While independent guidelines and frameworks for sustainability reporting exist (s.a. GRI, AA1000 and as part of ISO14001) there is no comparable framework offering performance assessment. Without this and yet without an underlying maturity model CIOs lack the ability to benchmark their performance against competitors.

IV. EMERGING TECHNOLOGIES FOR SUPPORTING CORPORATE SUSTAINABILITY

Emerging technologies offer the potential of reducing costs and improving sustainability by creating new ways of working. This section discusses how emerging technologies can provide support for CIOs to meet the requirements of sustainable information systems management. It focuses on Cloud Computing, Mobile Communications and Social Media and what role they can play in supporting increased corporate sustainability.

A. Cloud Computing

Cloud Computing offers many benefits for businesses needing to improve their sustainability. At its simplest, Cloud Computing is the provision computing as a service over the Internet. There are many definitions of what constitutes Cloud Computing [24] and an equal amount of hype [25]. There are four fundamental characteristics of Cloud Computing which is compatible with sustainability, abstracted or virtualized resources, elastic resource capacity, programmable self-service interface and a pay-per-use pricing model. These characteristics enable the requirements for corporate sustainability to be met in a variety of ways. The virtualization of resources allows previously heterogeneous platforms to be merged as a single resource which increases the possibility of investment and return on energy efficiency technologies. The homogenisation of IS infrastructure increases the possibility increased resource utilisation and therefore the reduction in overall resource requirements. In order to deal with the inevitable peaks and troughs in Information Systems demand, CIOs have to provision for enough resource capacity to deal with the most extreme load. Having the elastic resource capability of Cloud Computing frees the CIO to provision only the resources needed for day-to-day loads. Cloud Computing providers can deal with excess loads at certain busy periods, e.g. the December retail period. This offers the potential of a dramatic reduction in cost and environmental impact as resource requirements are reduced.

Utilising commercially managed resources forces CIOs to make decisions about the use of resources - it is easy to overprovision budgets for in-house computing resources, but difficult to justify excessive daily billing when utilising Cloud Computing resources. With many organizations moving to Cloud Computing providers, there is the possibility of anonymous benchmarking between organizations which will enable sustainability performance evaluation. In addition, the outsourcing of hardware and software provision to third-party providers removes the need for maintenance of IS resources, leading to reduced environmental footprint and cost. The decision to adopt a Cloud Computing strategy will place an organisation in a flexible position to rapidly take advantage of further technological improvements, such as the integration of Cloud Computing with wireless communications [26]. In this way, the organisation is better placed to focus on sustainability when the opportunity arises. On the global scale, the centralisation of computing infrastructure can take advantage of economies of scale to improve sustainability. Finally, the electricity and cooling cost of a large-scale Cloud Computing operation will be lower than the many distributed resources.

B. Mobile Communications

One of the most disruptive emerging technologies currently is Mobile Communications. The increasing ubiquity of wireless Internet access and powerful mobile devices is changing the way people work and play. With mobile communications, the CIO has a powerful technology that provides opportunity to meet stakeholder sustainability pressures. Mobile communications is about providing people the flexibility to remain constantly in contact with their workplace. The combination of Mobile Communications and Cloud Computing enables employees to work physically detached from the organisations infrastructure, either at home or on the move. This provides the CIO with opportunity to reduce the organisations overall footprint and address employees' demand for increased workplace flexibility. Reducing the size of the workspace by using flexible workspaces and meeting venues is a simple effect of the increased flexibility of mobile communications.

C. Social Media

Social media is a growing emerging technology that allows diverse users to interact socially online with a diverse array of sites been developed to support different activities. The flexibility of communication offered by social media presents both challenges and opportunities to organisations [27]. Real-time communication with stakeholders and employees offers the CIO the ability to discover their concerns. This is especially true of sustainability, where concerned individuals are proactive. CIOs reaching out to interact with the public on sustainability strategy and policy will bring positive light to the organisation. Social Media opens opportunities for distributed collaborations, easing the pressures on infrastructure and creating a more sustainable corporate environment. Collaborative and virtual projects have less impact on the environment and enable more flexible working. For the advantages of social media to be realised in the context of corporate sustainability there must be a consistent strategy at the organisational level and care must be taken to use the most appropriate medium.

D. Summary

This Section has shown that modern emerging technologies can help aid the CIO meet the growing sustainability pressures effecting them. All of the technologies discussed have the commonality that they enable more flexible and modern business practices. Proper considered use of these technologies can lead to meeting both sustainability and budgetary goals.

V. CONCLUSIONS

This paper has argued that there is a need for an increased focus on sustainability in Information Systems Management. It has highlighted the important issues of corporate sustainability and strategic IS management in the context of sustainability. Through an extensive survey of global technology companies, a comprehensive list of stakeholders with respect to sustainability and IS management was discussed. A detailed requirements analysis was presented for sustainable information systems management. It has argued that by exploiting emerging technologies, the CIO of large organisations can improve short and long term sustainability of those organisations.

REFERENCES

- [1] Brundtland Commission, "Report of the world commission on environment and development: Our common future," 1987.
- [2] United Nations, "2005 world summit outcome," 2005.
- [3] J. Elkington, *Cannibals with forks: the triple bottom line of 21st Century business*. Oxford: Capstone Publishing, 1998.
- [4] M. J. Epstein, *Making sustainability work: best practices in managing and measuring corporate social, environmental and economic impacts*. San Francisco, CA, United States: Berrett-Koehler Publishers Inc., 2008.
- [5] R. Kumar and L. Mieritz, "Conceptualizing 'green' IT and data center power and cooling issues," 02/10/2010 2007.
- [6] G. Boccaletti, M. Lffler, and J. M. Oppenheim, "How it can cut carbon emissions," 2008.
- [7] N.-H. Schmidt, "Towards a procedural model for sustainable information systems management," E. Koray, M. K. Lutz, and Z. Rudiger, Eds., vol. 0, 2009, pp. 1–10.
- [8] McKinsey, "IT's carbon footprint," 2009.
- [9] D. C. Esty and A. S. Winston, *Green to gold : how smart companies use environmental strategy to innovate, create value, and build competitive advantage*. Hoboken, N.J., United States: Wiley, 2009.
- [10] A. Molla and V. Cooper, "Green IT readiness: A framework and preliminary proof of concept," *Australasian Journal of Information Systems*, vol. Vol. 16, no. No. 2, 2009.
- [11] R. T. Watson and M.-C. Boudreau, "Information systems and environmentally sustainable development: Energy informatics and new directions for the is community," *MIS Quarterly*, vol. 34, no. 1, pp. 23–38, 2010.
- [12] M. T. Ijab, A. Molla, A. E. Kassahun, and S. Y. Teoh, "Seeking the "green" in "green is": A spirit, practice and impact perspective," 2010.
- [13] S. Schaltegger and F. Figge, "Environmental shareholder value: economic success with corporate environmental management," *Eco-Management and Auditing*, vol. 7, no. 1, pp. 29–42, 2000.
- [14] P. S. Wisner, M. J. Epstein, and R. P. Bagozzi, *Organizational Antecedents and Consequences of Environmental Performance*. Emerald Group Publishing Limited, 2006, vol. Vol. 3, pp. pp. 143 – 167.
- [15] Datamonitor, "Top 50 global technology companies," 2009, available online at <http://www.computerwire.com/companies/lists/list/?listid=7A7B551F-A6C8-47AC-B3AE-3879873B5E23>.
- [16] H. K. Anheier, M. Glasius, and M. Kaldor, *Global Civil Society 2001*. Oxford University Press, 2001.
- [17] G. Jordan, *Shell, Greenpeace and Brent Spar*. Palgrave Macmillan, 2001.
- [18] A. LaPlante, "MBA graduates want to work for caring and ethical employers," 2004, available online at http://www.gsb.stanford.edu/news/research/hr_mbajobchoice.shtml.
- [19] N. Stika, "Sustainability improves productivity and adds value to your business," 2010.
- [20] S. Murugesan, "Going green with it: Your responsibility toward environmental sustainability," *Cutter Business - IT Strategies Executive Report*, vol. Vol. 10, no. No. 8, 2007.
- [21] M. S. Lane and A. Koronios, "Critical competencies required for the role of the modern cio," 2007.
- [22] M. Chun and J. Mooney, "Cio roles and responsibilities: Twenty-five years of evolution and change," *Information & Management*, vol. 46, no. 6, pp. 323–334, 2009.
- [23] J. E. Austin, R. Gutierrez, and E. Ogliastri, *Effective Management of Social Enterprises*. Harvard University Press, 2006.
- [24] L. M. Vaquero, L. Rodero-Merino, J. Caceres, and M. Lindner, "A break in the clouds: towards a cloud definition," *SIGCOMM Comput. Commun. Rev.*, vol. 39, no. 1, pp. 50–55, 2009, 1496100.
- [25] R. Buyya, C. S. Yeo, S. Venugopal, J. Broberg, and I. Brandic, "Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility," *Future Gener. Comput. Syst.*, vol. 25, no. 6, pp. 599–616, 2009.
- [26] K. Lee, D. Murray, D. Hughes, and W. Joosen, "Extending sensor networks into the cloud using amazon web services," in *Networked Embedded Systems for Enterprise Applications (NESEA), 2010 IEEE International Conference on*, 2010, pp. 1 – 7.
- [27] A. M. Kaplan and M. Haenlein, "Users of the world, unite! the challenges and opportunities of social media," *Business Horizons*, vol. 53, no. 1, pp. 59 – 68, 2010.