



International Journal of Advanced Research in Education and Technology (IJARETY)

Volume 12, Issue 4, July-August 2025

Impact Factor: 8.152



Transforming IT Sustainability with Service-Oriented Architectures and Life Cycles

Surya Sekhar Nag, Vinayak Arjun Singh Dhami, Utsav Koushik

Department of MCA, CMR Institute of Technology, Bengaluru, India

ABSTRACT: The main aim of the new field called IT sustainability is to help companies use their computer resources more wisely while maintaining or even improving their overall performance. The first phase of these efforts is known as "green computing," which mainly focuses on reducing energy use in data centres and other tech equipment like desk tops and projectors. The advantages of green computing, such as lowering power use and cutting down on a company's carbon footprint, are clear and can be achieved quickly. However, to go beyond just internal green initiatives and turn sustainable IT into a competitive edge and part of a company's long term sustainability plan, more focus needs to be placed on how the next stage of sustainable IT practices can support and contribute to the company's broader sustainability goals. At the same time, these sustainable IT strategies must still meet the core needs of IT performance to support business productivity. As further companies move from product- grounded approaches to intertwined service models and Sustainable IT is presumably going to have a bigger impact on how client value is created and how people's quality of life is bettered through services. This paper will explore colourful aspects of sustainable IT, namely how it can be offered as a service, and give styles to more link it with a company's overall sustainability pretensions.

I. INTRODUCTION

In the data early days, sustainable IT strategies substantially aimed to reduce the costs and environmental goods of data centers. Over the once ten times, as centers have come a crucial part of IT planning, companies have decreasingly used green computing approaches. These styles punctuate how energy used by IT systems connects to a company's overall carbon emigrations. Large enterprise data centers use about a portion of the energy and produce a significant part of the carbon footprint for businesses[15].

II. DEVELOPING A SERVICE ORIENTATION

Lately, Vargo and Akaka made it clearer how the service dominant (S- D) sense approach is different from the goods dominant (G- D) sense approach. One main difference is how value is created and participated. In G- D sense, services are seen like products commodity redundant or impalpable that can be vended after a product is bought. Services are created like products, as labors that give value and are offered to guests in return for plutocrat. This is why G D sense is erected around the idea of swapping value. On the other hand, S- D sense views services as not counting on goods, indeed though goods can still be part of delivering a service. In this case, value is created together with the client. It's based on the idea that value is used rather than just traded. Co-creation is the process of suggesting what value should be, agreeing on it, and also making it be through two service systems working together. These systems combine their coffers to produce value and give a service experience (V and E). Because guests are laboriously involved with the service provider in creating value, the outgrowth tends to be more client-centered and satisfying.

The differences between G- D and S- D sense help us understand how sustainable IT is changing over time — from a focus on products and services to a stronger focus on services. The first surge of sustainable IT, which concentrated on green computing, is an illustration of G- D sense. It centered on product aspects of business value, like cutting costs (similar as energy use) and adding benefits (like lower carbon bottom prints), without involving guests or other service systems in creating value together. Green calculating naturally follows the design- figure- sell model of value exchange. To insure a alternate swell of sustainable IT, IT associations should involve all internal staff and guests, as well as other layers of their business ecosystem. They should produce value so as to concertedly bring generalities to vend that address environmental conditions in terms of genuine practical value. In short, for an IT to be sustainable, it needs to be a genuine service suitable of furnishing real and continuing value to its guests.

A. Business Value, Customer Value, and Societal Value

IT departments now need to easily demonstrate how their sweats affect the company's fiscal performance. Business value is the overall benefit a company gains from IT services and systems. To achieve this, IT spending must connect

with business pretensions to further serve guests Business value generally appears as increased profit or lower charges, which together meliorate the return on IT investments (2). While this strategy recognizes the significance of customer satisfaction, it mainly focuses on generating financial returns for the business What businesses bear is an approach to addressing CSR, particularly sustainability, that's similar to the format employed for business strategy. As a result, business value is frequently measured by short- term, cost-concentrated criteria like reduced costs, smaller workers, advanced productivity, system vacuity, threat avoidance, abatements, or loss forestallment. While these criteria prove to be helpful, they may not capture the long- term benefits for guests and society that eventually impact the company. This idea of business value comes from goods- dominant (G- D) sense, where IT goods and services are produced — occasionally with client involvement — and also vended to guests. Although this process may meet client requirements, it does n't produce participated value. For illustration, the early phase of green computing concentrated substantially on reducing energy costs. While this approach generated gains for companies and served society by lowering CO2 emigrations, the short sighted, cost- cutting strategy and limited collaboration with stakeholders could n't insure long- term benefits. therefore, fastening solely on business value is shy for creating continuing IT services. client value, conversely, is the overall benefit guests perceive compared to what they're willing to pay (21)(22). Prioritizing client value enables IT associations to widen their perspective beyond internal business pretensions and engage proactively with guests both collectively and in requests. The quality and depth of these relations are pivotal. From G- D sense's point of view, engaging with guests translates to erecting ongoing inter conduct where value is concertedly created rather of in segmentation. what they want in terms of new products or services, delivering those products, and then checking customer satisfaction through surveys to understand their perception of the experience .This situation would describe co-production and the exchange of value—IT services not IT service. It leaves lots of room for the development of gaps between expectations and reality From an SD logic perspective, a sustainable IT service can be viewed as an ongoing interaction between two service systems—the provider and the customer—to suggest, accept, and achieve value by combining their resources to co-create value that fulfills eco nomic, ecological, and societal needs. This describes the co creation of value- in- use for an IT service. Yet, a short- term focus on client value, whether co-created or not, which is generally used due to short product lifecycles and competitive pressures, might not be enough to insure a sustainable IT service. Some guests might be open to considering their long- term requirements from a societal angle, but for utmost IT druggies, cost and performance are the crucial facbluffs impacting their choices (10). Societal value encour periods associations to incorporate social responsibility and sus tainability into their operations. Business for Social Re sponsibility, a leading CSR association, defines soci etal value as achieving business success in a way that re spects ethical principles, people, communities, and the environment. Companies should aim to fulfill their request pretensions in a manner that enhances the long- term well- being of customers and society. still, these pretensions are frequently perceived as clashing, indeed though they're actually interconnected and infrequently align with the company's overall busi ness strategy. sweats to ameliorate societal value are frequently not as effec tive as they could be. utmost of these sweats warrant proper focus and calculate on a G- D sense approach that primarily reduces pitfalls, lowers costs, or enhances the company's reputation without involving stakeholders. This is generally referred to as value- in- exchange that doesn't consider co creation of value. What's demanded is an S- D sense approach that authentically involves stakeholders in sustainability as a service toco-create value- in- use, which benefits both society and the business. Table 1 summarizes the value discussion in relation to green computing and sustainable IT ser vice. herbage computing has the implicit to produce all three types of value. still, its short- term and low engagement approach aligns further with a business value G D sense exposure. herbage computing can also generate a lot of client and societal value. But the low engagement approach that lacksco-creation can lead to a lack of understanding about how to align strategy with guests and society. In contrast, the long- term, high engagement, co creation, S-D sense approach that defines sustainable IT ser vice is stylish for creating continuing client and societal value.

III. THE EVOLUTION OF SUSTAINABLE IT

The IT industry is a great example of the Vargo and Lusch idea that a service is “the use of skills to help someone else.” But in the past IT worked more like a product-focused business, creating and setting up I according to what it thought customers needed. The main thing was to ensure sufficient availability power and capability to handle business requirements. Problems like structure energy use cooling, and space for data centers weren't given important attention because they were seen as always being available and affordable. Unfortunately, these issues, especially high energy costs and environmental worries, have now come major challenges when setting up new IT system.

A. Green Computing

Major corporate data centers are able to bring between 500 million and 1 billion bones. They use a lot of energy, which is why green computing strategies have substantially concentrated on reducing power costs in data centers. This helps lower the auto bon footmark for IT associations. Moving toward a green data center involves combining new styles for

man growing power and cooling with energy-effective tackle, virtualization, software, and better ways to manage workloads and power operation (11). Table 3 gives an overview of the main green computing strategies. Tables 2 and 3 show that green computing is mostly about products. All the main factors affect energy costs and operational efficiency, which in turn influence the cost of products and services. High energy use and inefficient products and services can harm the ability of IT to create value. The solutions to these energy and efficiency issues are also mostly product-based. All the strategies aimed at reducing energy use and improving efficiency. Cloud computing stands out as an exception because it also offers a new business model. This model not only improves efficiency and reduces costs but also has the potential to shift IT towards becoming a service. It provides computing services to customers that can be accessed on demand through a subscription model, without the need for upfront investments in infrastructure or other resources.

B. Sustainable IT

The emergence of sustainable IT strategies is driving sustainability solutions beyond energy use and product and services considerations. Existing green computing strategies, which have been mostly inward looking and cost driven, would only indirectly impact sustainable IT strategies since they are not focused on benefitting others. However, even those companies at the forefront of IT sustainability leadership define the concept in product terms. For example, Intel Corporation has defined IT sustainability as “encompassing the study and practice of using information and computing technology resources efficiently and effectively in ways that the planet can support indefinitely”. This definition may imply engagement with and action for the benefit of stakeholders; but it more likely reflects Intel’s product-oriented DNA that has a distinct green computing flavor. But it does open the door to services in a G-D logic way. IBM’s approach is more oriented toward sustainability as a service. IBM does not directly offer a definition for sustainable IT, but it does highlight the dependence of corporate sustainability strategies on the ability to leverage information from operations, supply chain, and customers. They view customers as “partners in sustainability” and state that “collaboration with stakeholders, customers, and even competitors, is key in both setting standards for sustainability and in enabling the necessary transparency. Since sustainability is a complex discipline the authors conclude that insight and engagement are necessary if effective action is to be taken. Their approach is more consistent with S-D logic. In addition to Intel and IBM’s corporate efforts in IT sustainability, there are many other initiatives. For instance, Dell focuses on making energy efficient products [7] to show their dedication to the environment. Another step is creating basic compliance programs. ENERGY STAR is a program run by the U.S. Environmental Protection Agency and the U.S. Department of Energy, which helps everyone save money and protect the environment by promoting energy-efficient products and practices. In Japan, there is the Eco leaf program that measures many more aspects of computer production [23]. For example, a label for a Fujitsu Life Book laptop can take up two detailed pages of sustainability data. The label includes an executive summary of “Life Cycle Impacts” and a breakdown of “Global Warming Impact” [16]. Moving toward an S-D logic related definition, sustainable IT can be defined as the use of IT knowledge and technologies for the benefit of customers and other stakeholders, which enhances long-term mutual economic, environmental, and social wellbeing. This definition encompasses the long-term importance of IT to the business organization, its customers (internal and external), other stakeholders, and society at large. To borrow a sustainable IT approach, IT associations would need to change how they’re managed. IT would have to come much further interactive with its guests in creating value and aligning with business strategy.

IV. CONCEPTUALIZING A FRAMEWORK FOR SUSTAINABLE IT

When developing IT results, numerous IT associations don’t consider the full environmental impact of their product and service designs. This frequently happens because they prioritize short-term costs and business value. However, similar as how saving energy lowers carbon emissions, that benefit tends to be seen as important. If reducing costs also helps the terrain, still, it’s doubtful that an IT department can achieve sustainability pretensions across the company without support from directors. For IT as a service to be authentically sustainable, there needs to be a unified plan for sustainability throughout the entire association. Only also can different functions like IT, installations, force chain, manufacturing, finance, and marketing unite effectively. The first surge of green computing substantially concentrated on saving plutocrat. The issues and remedies in this field are already well known. The challenges and solutions in this area are already known. The next phase, often referred to as sustainable IT, examines IT from a broader perspective and focuses on its overall impact on society. The driving force behind sustainable IT is corporate social responsibility (CSR), which emphasizes a company’s impact on the economy, the environment, and society. Usually, these three dimensions are described using the “triple bottom line” (TBL) model. The concept of corporate citizenship emphasizes that a company should align its goals with the economic, environmental, and social expectations of its key stakeholders. In this way, sustainable IT goes beyond short-term profits and ensures that technology contributes to both business development and the well-being of society as a whole.

A. Strategy Oriented Framework for Sustainable IT

A considerable amount of time was required for people to realize that sustainable IT is a crucial part of aligning the IT department with society and the company's overall CSR strategy. One reason for this delay is that corporate approaches to CSR are often scattered and not connected to the main business strategy. This lack of connection makes CSR efforts less effective and makes it hard to see the biggest chances to help both society and the company. Companies often look at CSR, especially sustainability, in the same way they think about business strategy. Doing things like saving energy, cutting down emissions, reducing pollution, or conserving water is good for the environment and may look impressive in reports, but such efforts don't always help the business unless they are part of a broader, coordinated plan. For sustainable IT to really work, it's important to understand how the IT function connects with society and how it fits within the company's overall goals. This means that IT should not just follow the business strategy—the business strategy itself should also reflect sustainability. To make this happen, companies need to treat sustainability with the same importance as exploring new markets, developing technologies, staying ahead of competitors, or forming partnerships. It's not an easy task, but the ideas put forward by Porter and Kramer can provide useful direction.

B. Understanding

Understanding the competitive landscape involves assessing the strength and quality of a company's resources, the rules and regulations that guide competition, the size and complexity of customer demands, and the accessibility and capability of ecosystem partners—particularly those connected to the value chain. For the IT department, this means analyzing how sustainability challenges might affect products and identifying the points where these concerns will have the greatest impact.

C. Choosing

Selecting the right sustainability issues is crucial, because it isn't realistic for an IT organization to address every potential challenge. Doing so would demand excessive resources, while the outcomes might not be worthwhile. A more effective approach is to focus on the issues most closely tied to strategic business objectives. The selection should be driven by opportunities to create shared value—providing benefits not only to the organization itself but also to the broader business environment.

D. Creating a sustainability agenda

The sustainability agenda should actively involve stakeholders in finding ways to achieve both economic gains and environmental benefits simultaneously. Within this agenda, it is important to distinguish between responsive and strategic sustainability. Responsive sustainability reflects a company's role as a responsible corporate citizen, addressing stakeholder concerns and dealing with broad issues that, while necessary, contribute little direct value to the business and are often focused on reducing risks in the value chain. Strategic sustainability, on the other hand, targets areas that directly strengthen the company's competitiveness and support long-term growth.

E. Creating a sustainability Dimension

Most companies have struggled to develop sustainable IT strategies that work at scale while also meeting social responsibility goals. Although many organizations launch environmental initiatives, these efforts often lack proper coordination and integration. Typically, such initiatives are driven by five main factors: customer safety concerns, legal and regulatory requirements, compliance obligations, community expectations, and the protection of corporate image. The ideal sustainability plan needs to achieve dual objectives which include business support and environmental protection.

TABLE I: VALUE DIMENSIONS IN GREEN COMPUTING AND SUSTAINABLE IT SERVICES:

Value Dimension	Green Computing / Sustainable IT Service	Service-Dominant (S-D) Logic
Business Value	Primary driver of adoption G-D logic Products and services co-produced Value-in-exchange Low engagement Short term NA	Primary driver of adoption S-D logic Service co-created Value-in-use High engagement Long term
Customer Value	Secondary driver of adoption G-D logic Products and services co-produced Value-in-exchange Low engagement Short term	Primary driver of adoption S-D logic Service co-created Value-in-use High engagement Long term
Societal Value	Secondary driver of adoption G-D logic Products and services co-produced Value-in-exchange Low engagement Short term	Primary driver of adoption S-D logic Service co-created Value-in-use High engagement Long term

V. CONCLUSION

The initial phase of green computing primarily focused on making data centers run more efficiently. The focus was on cutting down infrastructure costs, managing workloads and power use, keeping temperatures in check, optimizing product designs, embracing virtualization, and shifting to cloud computing. These efforts not only helped companies lower their operating costs but also reduced their environmental impact by cutting down on energy consumption. As for the next phase of green IT, it's still in the works and not fully defined yet. It's expected to go beyond just operational efficiency by weaving IT sustainability into corporate social responsibility (CSR) and broader sustainability objectives. This next stage will require developing clear plans with baseline metrics, rethinking business processes, boosting engagement from customers and stakeholders, and fostering a cultural shift within companies towards adopting new sustainable practices. As shown in Figure 1, IT strategy is affected by many complex factors. IT strategy should become more open and closely linked with the company's overall strategy. This paper suggests that a sustainable IT strategy ought to shift attention from only on green computing products and services and creating business value. Instead, it should take a customer-focused approach, working closely with customers and other stakeholders to create lasting value for both customers and society.

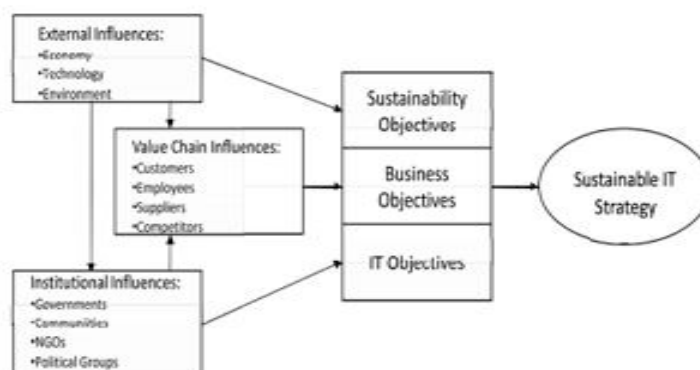


Fig. 1. The Influence of Sustainable IT Strategy

A sustainable IT framework, in accordance with Porter and Kramer, is suggested to align business goals with sustainability requirements. Much more effort has to be made towards delineating the discipline of sustainable IT. Better groupware will be necessary. Its also possible that the true benefits of sustainable IT won't be in reducing the inefficiency of physical infrastructure, computers, and software use. Rather, it will be in applying computing resources and IT expertise to address difficult environmental and social issues that previously have been difficult to address. Future studies must examine the interrelationship between customer, business, and societal value, along with how

TABLE II
KEY FACTORS DRIVING DATA CENTER GROWTH AND ENERGY CHALLENGES

No.	Factor	Summary
1	Rapid growth of the Internet	Rising demand from online services, business digitalization, legal compliance, and e-government initiatives, driving 20% annual data-center growth.
2	Increasing equipment power density	Smaller, high-performance servers (e.g., blade servers) have increased power density over 10x since 1996.
3	Increasing cooling requirements	Higher server density raises heat loads, requiring 1–1.5 W cooling per watt of power used.
4	Increasing energy costs	Power costs now match equipment costs over a server's life; carbon policies may further increase expenses.
5	Restrictions on energy supply	Power shortages in some US cities force datacenters to seek remote low-cost power sources.
6	Low server utilization rates	Large data-centers average only 5–10% utilization, wasting energy and operational costs.
7	Environmental impact awareness	Data-centers produce significant CO ₂ emissions, projected to quadruple by 2020, with manufacturing impact often ignored.

they could be redefined to emphasize how value is being utilized, rather than the traditional static method employed in marketing and economics. There is a need to define the aspects of sustainable IT as a service and explore its effects under a service-dominant logic perspective. Lastly, research is needed to understand how the IT department's role is changing. It has moved from focusing on products to being a service provider. However, the IT department still thinks in terms of products and services as products, following a goods dominant logic. What steps are needed to truly make IT a service-oriented organization?

REFERENCES

- [1] Auseklis, N., Demirkan, H., Harmon, R. and Hefley, B., “Design ing IT Services for Sustainability and Business Value,” 2nd Annual International Conference on Business and Sustainability: Designing Sustainability, Portland, OR, USA, October 15-17, 2008.
- [2] Baldwin, E. and M. Curley, Managing IT Innovation for Business Value, Intel Press, 2007.
- [3] L. A. Barroso and U. Hölze, “The case for energy-proportional computing,” IEEE Computer Society, vol. 40, no. 12, pp. 33–37, Dec. 2007.
- [4] L. Barreto, H. Anderson, A. Anglin, and C. Tomovic, “Product life cycle management in support of green manufacturing: Assessing the challenges of global climate change,” in Proc. Int. Conf. Comprehensive Product Realization (ICCPR 2007), Beijing, China, Jun. 18–20, 2007.
- [5] Bartels, A., Daley, E. and Ashour, M., “Global IT Market Outlook: 2009,” Forrester Research, Report, January 12, 2009.
- [6] D. Daoud, “Beyond power: IT’s roadmap to sustainable computing,” IDC Whitepaper, Oct. 2008. [Online]. Available: www.idc.com
- [7] Dell.Com, “Dell Highlights Progress on Energy-Efficiency Programs, New Products Feature Energy Savings, Exemplify Environmental Commitment,” Dell.com, October 23, 2006.
- [8] Demirkan, H. and St. Louis, R., “Computing IT’s Give-and- Take Role in Sustainability,” The Knowledge@W. P. Carey, April 23, 2008.
- [9] Demirkan, H., Kauffman, R.J., Vayghan, J.A., Fill, H-G., Karagiannis, D. and Maglio, P.P., “Service-Oriented Technology and Management: Perspectives on Research and Practice for the Coming Decade,” The Electronic Commerce Research and Applications Journal, Volume 7, Issue 4, 356- 376, Jan 2009.
- [10] Deloitte Tohmatsu, The next wave of green IT. Boston, MA: CFO Publishing Corp, CFO Research Services, 2007.
- [11] J. Dietrich and R. Schmidt, “The eco-friendly data practices center,” IBM Global Services, White Paper, May 2007, 21 pp.
- [12] Esty, D.C. and A.S. Winston, Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage, Hoboken, NJ: John Wiley Sons, Inc.,2009.
- [13] A. Fanara, Report to Congress on server and data center efficiency: Public Law 109-431, U.S. Environmental Protection Agency, Energy Star Program, 2007, 133 pp. [Online]. Available: Retrieved Feb. 25, 2009.
- [14] J. Foley, “Google in Oregon: Mother nature meets the data center,” InformationWeek’s Google Weblog, Aug. 24, 2007.
- [15] Forrest, J. M. Kaplan, and N. Kindler, “Data centers: How to cut carbon emissions and costs,” The McKinsey Quarterly, no. 14, Winter 2008.
- [16] Fujitsu Computer Systems Corporation, “Fujitsu Laptop Energy Efficiency a Key Component of a Strong Environmental Policy,” July 23, 2007.
- [17] S. Hamm, “It’s too darn hot,” BusinessWeek.com, Mar. 20, 2008.
- [18] S. E. Hanselman and M. Pegah, “The wild wild waste: e-waste,” in Proc. ACM SIGUCCS Conf., Oct. 7–10, 2007, pp. 157–162.
- [19] Harmon, R.R. and N. Auseklis, “Sustainable IT Services: Assessing the Impact of Green Computing Practices,” PICMET 2009 Proceedings, PICMET/IEEE.
- [20] R. R. Harmon, H. Demirkan, B. Hefley, and N. Auseklis, “Pricing strategies for information technology services: A value-based approach,” in Proc. 42nd Hawaii Int. Conf. on System Sciences (HICSS-42), IEEE Computer Society, Jan. 2009, pp. 1–10.
- [21] R. R. Harmon and G. Laird, “Linking marketing strategy to customer value: Implications for technology marketers,” in Innovation in Technology Management, Kocaoglu, et al., Eds. Portland, OR: PICMET/IEEE, 1997, pp. 897–900.
- [22] Japan Environmental Management Association for Industry, “Guidelines for the Introduction of the ECO-LEAF Environmental Label,” JEMAI, April 2002.
- [23] E. Knorr and G. Gruman, “What cloud computing really means,” InfoWorld, Apr. 7, 2008. [Online]. Available: <http://www.infoworld.com>
- [24] G. Lawton, “Powering down the computing infrastructure,” Computer, vol. 40, no. 2, pp. 16–19, Feb. 2007, doi: 10.1109/MC.2007.58

International Journal of Advanced Research in Education and Technology

ISSN: 2394-2975

Impact Factor: 8.152