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Showcasing Seventh Generation's Environmental Sustainability Initiative Using Appropriate Information Systems Support

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Abstract

This study explains the implementation of an information systems that supports the environmental and sustainability goals of Seventh Generation, seller of nondurable household cleaning products, using the technology-organization-environment (TOE) framework of Tornatzky and Fleischer. This qualitative study case study approach and extensive literature review are used and applied to a single firm to validate hypotheses offered. The hypotheses offered in this study are positively confirmed --- that firms pursuing environmental and sustainability goals will: (1) respond to key environmental context factors; (2) gain top management support for these initiatives; (3) espouse supporting corporate values; (4) collaborate with appropriate stakeholders in environment to achieve sustainability goals; (5) use appropriate organizational mechanisms; and (6) invest in appropriate information technologies to support the information systems required for sustainability.

Keywords

Sustainability; environmental issues; information systems and the environment; technology-organization-environment framework

1. Introduction

This study features the information systems implementation experience for environmental sustainability of Seventh Generation (7G), a Vermont-based firm that has been cited as among the top 10 brands by the 2008 Green Brands Index and writer of the "Best Small and Medium-Sized Enterprise (SME) Sustainability Report as recognized by CERES and the Association of Chartered Certified Accountants. Sustainability has been defined as the capability of a firm "...to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs." (World Commission on Environment and Development 1987). The quest for sustainability among forward-looking firms will alter the way they think about their products, business processes, technologies, business models, and relationships with key trading partners in their supply chains (Nidumolu *et al*, 2009). The objective of this study is to use Tornatzky and Fleischer's (1990) technology-organization-environment (TOE) theoretical framework to make the case for the use of information systems appropriate for supporting environmental and sustainability goals of 7G. This firm has modelled a pioneering approach to embedding corporate social responsibility in its mission statement as it pursues its business of

selling nondurable household products. The single case study approach is used in this qualitative study.

7G, a small but visible purveyor of healthy, safe household and personal care products, highlighted the health benefits of its products especially for sufferers of asthma, allergies, and chemical sensitivities. Chemical-based household and personal care products containing chlorine, petroleum products, and volatile organic compounds aggravate these health conditions. 7G's products have no chlorine or solvents and are based instead on vegetable oils and natural ingredients. Sanguine prospects for the firm are based on two factors. First, there is the aging baby boomer generation that has both the money and health consciousness for living a prolonged and healthy life. Second, traditional distribution channels for nondurable household products such as supermarkets and grocery chains are currently searching for ways of differentiating themselves from megadiscount stores and warehouse chains such as WalMart and Costco that have inched into their market share in selling nondurable household products (Goldstein & Russo 2008).

2. Research question

This study seeks to answer the following research question:

(1) How can we explain the implementation of an information system focused on supporting environmental and sustainability goals of a firm based on the TOE framework using the 7G case study?

3. Literature review on the technology-organization-environment (TOE) framework

This study will use the technology-organization-environment (TOE) framework introduced by Tornatzky and Fleischer in the 1990s. This three-part framework identifies three contextual elements that influence technological adoption --- the environmental context, the organization context, and the technological context. The environmental context consists of the actors and scenarios that surround the firm --- the industry it belongs to and its suppliers, customers, competitors, and government or agencies that regulate its activities. The organizational context consist of relevant firm attributes such as its size, scope, centralization and formalization of its functions, complexity of its management structure, quality of its human resources, and amount of slack resources available to the firm internally. The technological context consists of the technologies the firm could use, which are available both internally and externally.

3.1 Environmental Context

Tornatzky and Fleischer (1990) describe the environmental context as the arena surrounding a firm, consisting of multiple stakeholders that could affect the fate of the firm. Industry members, competitors, suppliers, customers, the government, the community, etc., all can determine how a firm interprets the need for innovation, its ability to acquire the resources for pursuing innovation, and its capability for actually deploying it. These stakeholders could either support or block technological innovation. Thus, the firm needs to delicately manage its relationships with these stakeholders in order to arrive at effective decisions concerning technological innovation. The authors consider a wide range of environmental factors that could impinge on a firm, but for the purposes of this paper, only those factors pertinent to the 7G case study will be

described.

Changing market and competitive conditions could prod firms to use various forms of innovation. As a strategic move, most firms naturally exploit their strengths or their competitors' weaknesses in order to gain an edge by manipulating product price, quality, or customer service levels, among critical success factors. Acting rationally, firms also align their technology strategies and policies with their overall business goals.

Government regulation is also another powerful tool for constraining a firm's operational activities, increasing costs of production, and setting in motion an investigation of technologies that must meet specified mandatory criteria. Also, it is government's place to be the overseer of corporate production activities that have real and/or potential threats to the well being of consumers and society in general. If need be, government, at times, stipulates the type of technological innovation that a firm must use.

Finally, customer power is a force to be reckoned with. Dominant customer firms exert their power to shift their suppliers' production activities and/or business processes to comply with its peculiar needs.

3.2 Organizational Context

From a broad point of view, Tornatzky and Fleischer (1990) viewed a whole host of descriptive measures that would characterize the "organizational context" of their framework: firm size; the centralization, formalization, and complexity of its managerial structure; the quality of its human resources; and the amount of slack resources available internally; formal and informal linkages within and outside the firm; decision making and internal communication methods; and boundary spanning mechanisms to communicate with the external environment. Only selected aspects of this broad list will be illustrated using the 7G case study.

The concept of the "organic" versus the "mechanistic" organizational system is also relevant here (Burns & Stalker 1961). Frequent lateral communication, decentralization of leadership and control, and active networking both within and outside the firm are hallmarks of the "organic" system. Building interorganizational collaboration mechanisms is fundamental in meeting the needs of interlocked technological and electronic coordination linkages enabling supply chain partnerships.

A number of formal linking structures to promote "lateral relations" are useful to the firm both internally and externally (Galbraith 1973): direct contact between managers; creating liaison roles; creating ad hoc task forces; using permanent teams; creating integrating roles; changing to managerial linking roles; and establishing a matrix form of management.

The "organic" system which appears to be the more appropriate one during times of change such as those typified by the adoption of new technological innovations (Aiken & Hage 1971). Executives at top and mid levels can give major changes momentum by (Tushman & Nadler 1986): (1) developing and communicating a clear image of the firm's strategy, core values, and statement about the technology's role in meeting this strategy; (2) sending consistent signals both within and outside the firm about the value of the innovation; and (3) creating a team responsible for crafting an appropriate vision relevant to the innovation through the use of the team members' technical, social, and conceptual skills.

3.3 Technological Context

Tornatzky and Fleischer (1990) presented their “systems design perspective,” which is a synthesis of different systems implementation approaches previously recognized in management information systems (MIS) literature. The authors highlight the best aspects of the following approaches: technocentric, sociocentric, conflict/bargaining, systems life cycle, and socio-technical systems. The following are selected key steps in the “systems design perspective” that will be illustrated using the 7G case study.

(1) Understand the characteristics of the innovation

In understanding the characteristics of the innovation, Tornatzky and Fleischer initially draws ideas mainly from the technocentric approach, which they later modify. The technocentric approach espouses the notion that technological factors dominate the implementation experience, thus, leading to the following consequences: (a) there should be a detailed technical plan for implementation; (b) methods engineering should help in the redesign of business processes and jobs; (c) the innovation should be able to be integrated with the existing technical system; and (d) technical criteria should be used in measuring implementation effectiveness (Rousseau 1988; Lawson *et al.* 1983; Gunn 1982). Tornatzky and Fleischer depart, however, from the strictly rationalist and technical view of the technocentric approach, which they view as incomplete. The authors recognize that technical characteristics of the innovation certainly impacts the implementation experience.

The “systems design perspective” also calls for a technology-organization match. For instance, borrowing from contingency theory in management, the perspective anticipates that organic organizational structures may be better suited in situations where there is a high level of uncertainty surrounding the technology or when the marketplace environment is undergoing dynamic changes (Collins *et al.*, 1988; Perrow 1979). Alternative organizational structures may have to be put in place in order to meet the requirements of certain technologies (Pasmore & Sherwood 1978).

The technology innovation could also influence how different parts of a firm need to coordinate and the manner in which their interdependence needs to be enabled. Implementation of information systems supporting environmental goals extends the level of coordination from internal integration to interorganizational integration within the supply chain context. It is also anticipated that the greater the technical complexity of the innovation, the more sophisticated the IT infrastructure that needs to be in place (Susman & Chase 1986).

(2) Develop measures of implementation effectiveness

A wholistic approach to measuring implementation effectiveness would include the perspectives of the various approaches. The technocentric approach uses technical criteria. The systems development life cycle approach emphasizes of the new system meets the needs requirements stipulated in the planning phase of the cycle. On the other hand, the sociocentric approach would investigate if the implementation of the technology has enhanced the social system’s functioning, if the deployment contributed to reaching the technology system’s stated organizational goals, and if the new technology has, in fact, led to the overall survival and growth of the firm. The conflict/bargaining approach would look if the new technology considered the interests, input, and involvement of all affected stakeholders and if they were satisfied with the outcomes of the new system. The socio-technical systems (STS) approach includes some aspects that overlap with the other approaches and would zero in on how the technical and social systems fit one

another in order to reach the technology deployment's goals and meet the demands of the external environment (Niepce & Molleman 1998; Pasmore 1988).

(3) Plan and pace implementation

Pacing technology implementation refers to the speed at which changes are unfolded, which could range anywhere from gradual to radical (Roitman *et al.* 1987). Quinn (1980) espouses incremental change arguing that technology changes with a broad scope requiring drastic changes could be both difficult to plan and manage. To control the rate deployment at a pace that organization can cope with is well within the scope of the sociocentric approach.

(4) Design or redesign the organization

The step on designing or redesigning the organization borrows heavily from the sociocentric approach with its focus on making the organization more flexible, humanistic, and open to changes brought about by the innovation (Tornatzky & Fleischer 1990; Zaltman *et al.* 1973; Hage 1980). Organization design consists of those activities related to defining role expectations within the firm affecting authority and coordination (Katz & Kahn 1978) and determining how information should flow within the organization (Galbraith 1973) and latitude for technical variances (Taylor & Assadorian 1985). Typical issues that need to be resolved in this step include: determining groupings and reporting relationships; use and forms of transitional structures; use of role definition to clarify the need for integration and differentiation within the firm; and the introduction or modification of technical standards.

(5) Modify human resources policies

This step involves modifying human resource policies involving employee selection, compensation, appraisal, and training --- all of which have important implications for innovation implementation (Ettlie 1988; Majchrzak 1988). Usually technological innovations bring with them new demands on employees that require motivational efforts to encourage affected employees to acquire new skills and put up with changed working conditions.

(6) Design or redesign jobs

The design and/or redesign of jobs are needed to ensure that the affected workers and the work system required by the innovation are linked (Tornatzky & Fleischer 1990). Methods analysis and task analysis are two of the most common means used to specify work behavior appropriate to the new technology adopted.

(7) Install the innovation and integrate with the existing system

The "systems design approach" synthesizes key points of the systems life cycle and socio-technical system approaches (Tornatzky & Fleischer 1990). Borrowing from the systems life cycle approach, the systems design approach prescribes the following: (a) incorporating end user needs into the requirements definition phase; (b) designing the new system so that it can integrate with the larger IT system that encompasses the firm; (c) ensuring the provision of resources for continued and reliable system maintenance and furthermore, providing for both incremental and radical system changes if called for in the future. On the other hand, following selected socio-technical system principles, the systems design approach endorses the following: (a) espousing "compatibility" by ensuring that the new system is consistent with the firm's long-term objectives by involving key stakeholders; (b) practicing "variance control and information

flow” by managing deviations or variances as soon as possible and at the point of origin and providing affected end users timely information feedback so they can control the variance; (c) establish appropriate “boundary locations” so that information, knowledge, and learning could be shared among all affected parties; (d) adopting “support congruence” whereby an appropriate social support system in the form of appropriate recruiting, training, reward structures, work assessment, promotion policies, corporate culture reinforcing human values for a high quality work life, etc., is designed to complement the new technological system; and (e) upholding “incompletion,” in the sense that the new technological system will be in a continuous state of flux in order to meet changing organizational objectives and needs and evolving technological forms (Liu *et al.* 2006; Palvia *et al.* 2001; Tornatzky & Fleischer 1990).

4. Propositions

This study presents the following propositions using the TOE framework in analyzing 7G’s use of information systems to support its environmental and sustainability goals:

Proposition 1: Leading-edge firms will respond to certain environmental context factors in undertaking their environmental and sustainability initiatives.

Proposition 2: Firms that seek to protect consumer health and safety will exhibit top management support for their environmental and sustainability initiatives.

Proposition 3: Firms that seek to protect consumer health and safety will espouse corporate values that support their environmental and sustainability initiatives.

Proposition 4: Firms that pursue environmental and sustainability goals will collaborate with appropriate stakeholders in environment in order to achieve these goals.

Proposition 5: Firms that pursue environmental and sustainability goals will use appropriate organizational mechanisms in order to achieve these goals.

Proposition 6: Firms that pursue environmental and sustainability goals will invest in appropriate information technologies to achieve these goals.

5. Research Methodology

This paper uses a single case study approach in aligning the concepts and guidelines prescribed by the TOE framework to 7G, producer of household care, baby care, personal care, and laundry care. The case study approach has been used as an appropriate methodology in testing exploratory propositions in investigating nascent phenomena prior to undertaking empirical research. Secondary sources gathered from literature reviews, content in the firm’s website, and published interviews were content analyzed using key concepts embodied in the TOE framework. 7G was chosen because of its unusual position of being a leader firm modeling corporate social responsibility and sustainability in the nondurable household products industry.

6. Research Findings

6.1 Environmental Context

Important societal developments serve as drivers for sustainability (Senge *et al.* 2010). First, industrialization has led to unsurpassed levels of physical good production and consumption, and global pollution and waste generation (Senge *et al.* 2010; Srivastava 2007; Beamon 1999).

Second, “civil society” stakeholders in the form of non-governmental organizations (NGOs) and citizen social activists have raised the pitch of their demands for corporate transparency in the use of the earth’s resources in producing goods and services (Senge *et al.* 2010; Lash & Wellington 2007; Porter & Kramer 2006). Ultimately, the business case for pursuing green initiatives will rest upon consumer dollars, and it is only a matter of time before the currently laggard and indifferent segment of the consumer marketplace ultimately catches up. This, in turn, will significantly affect B2B commerce and affiliated supply chains in that firms will require their suppliers to be respondent to these consumer demands (Mollenkopf *et al.* 2010; Ashembaum 2008; Goldenhersh 2009). There are, too, pressures exerted by domestic and foreign governments through the use of legislation and regulation to ensure compliance with green and sustainability mandates.

Third, disruptive technologies such as genomics, biomimicry, nanotechnology, information technologies, and renewable energy technologies stand to render energy-intensive industries obsolete (Senge *et al.* 2010). Fourth, global economic and social problems that relate with resource depletion, deteriorating ecosystems, climate change and global warming, poverty and inequity in developing countries have raised awareness for the need for worldwide resource conservation and renewal (Senge *et al.* 2010; Shrivastava 1995; Hart 1995; Commoner 1990). The competitive pressures that 7G faces in the mature nondurable household products industry help clarify its strategic stance towards its key competitors in the marketplace, namely firms like Procter & Gamble, Unilever, Kimberly-Clark, Colgate-Palmolive, Clorox, among others. Sales in the US of nondurable household products represents 50 percent of the total of US \$156 billion wholesale level revenues worldwide (Goldstein & Russo 2008). The intensity of competition in the industry is accounted for mainly by the stagnation of population growth and thus, shrinking market space, in primary markets in North American and the more developed European countries. Firms, therefore, relentlessly compete mainly on price, jockeying for strategically located shelf space in static distribution channels, and introducing innovative products. It is difficult to win brand loyalty as consumers view these products as undifferentiated and during these tough economic times, the price margins make the difference. The notable market demographic marked by the rise of the aging baby boomer segment has changed the dynamics of the industry somewhat. Patronage from baby boomers has increased lately as they view the use of green household products as one way of extending a healthy life as they age. Another dynamic at play here is the encroachment of large discounters like Wal-Mart and CostCo into the business. Mainstream supermarket chains like Albertson’s and Safeway known to carry these products have lost significant sales to these discounters and are looking to green products as one way to regain customer traffic.

7G, therefore, appears to be taking advantage of their market headway and brand capital by taking a stronger and more visible sustainability stance. 7G is addressing the important issue of consumer education in the use of green products by actively engaging its customers in the their website through the use of blogs, 7G online community called “Seventh Generation Nation”, and a label reading guide downloadable to one’s cellphone (Seventh Generation 2009).

Industry competition forces appear to matter more than pressures from government regulation. At the moment, there are no laws mandating manufacturers of cleaning products to list the ingredients used on their labels or to demonstrate the conduct of safety tests to customers (Carmichael 2011). Even though such household products are regulated by the U.S. Consumer Product Safety Commission under the Federal Hazardous Substances Labeling Act,

manufacturers of these products are not required to reveal these ingredients, which are considered their key trade secrets.

7G is one of the leader firms pioneering “green” and sustainable practices to address urgent global survival issues. Firm co-founder Jeffrey Hollender has set a mission statement for his firm to espouse the leadership role of being a responsible steward of the earth’s resources in the manner in which 7G produces and distributes its products. 7G is not merely reacting to a government regulation mandating the safety of the household cleaning, baby care, and personal care products that the firm sells. 7G is proactive in its commitment with key stakeholders in the environment to see to it that sustainability is upheld as a critical corporate mission.

The findings on 7G’s environmental context clearly support the hypothesis that the firm has responded to important environmental context factors in undertaking their environmental and sustainability initiatives.

7G is deeply committed to protecting consumers and holds them center stage in all its product initiatives --- new product development, continuing product improvement, product audits, etc. Aware of the fact that consumer education is not quite as advanced in the area of recognizing and understanding the health benefits and hazards associated with chemical product ingredients, 7G actively undertakes educational programs to raise the level of consumer sophisticated in detecting safe and unsafe products.

7G has also positioned itself as an active and effective collaborator with other stakeholders in the environment that would be concerned with sustainability: government regulatory agencies (e.g., U.S. Environmental Protection Agency or EPA), non-government organizations, organized social activists, suppliers, and manufacturers, in order to make a difference especially in passing relevant legislation and policies promoting sustainability. 7G sees itself as an active agent for redesigning the landscape populated by key power-wielding stakeholders and for educating not just consumers, but also firms and the general public on the concepts and principles behind sustainability and green supply chain management. 7G, in collaboration with Kaplan EduNeering, a large global education firm, has created the Sustainability Institute, an online learning program for training firms in the design of sustainability strategies and business practices (Seventh Generation 2009).

These findings support the hypothesis that firms pursuing environmental and sustainability goals will collaborate with appropriate stakeholders in environment in order to achieve these goals.

6.2 Organizational Context

7G espouses the following global imperatives: restore the environment, inspire conscious consumption, and create a just and equitable world (Seventh Generation 2009). Through the years, top management and employees worked on having a coherent set of corporate values and operating principles that align with their mission to become the world’s most trusted brand of authentic, safe, and environmentally responsible products for a healthy home and providing customers with the information resources needed to make intelligent product purchase decisions (Goldstein & Russo 2008). The firm’s operating principles consist of systems thinking, radical transparency, and influence beyond the firm’s size through innovation, education, and interaction (Seventh Generation 2009). The Values and Operating Principles Committee (VOPS)

consisting of employees and a senior management representative was organized to ensure that the firm's mission and vision are codified and communicated effectively (Goldstein & Russo 2008).

7G has been considered one of the exceptional firms that are in the most advanced stage or stage 5 of Senge's five stages along the path to the full integration of sustainability in a firm's strategy and purpose (Senge *et al.* 2010). Firms in stage 5 are founded by individuals who had the foresight of realizing the opportunities and even competitive advantage that sustainability brings, long before most other firms have even reached the point of regulatory compliance. These firms also make it a point to declare that their mission or purpose is to contribute to society and be regenerative.

This confirms the hypotheses that firms seeking to protect consumer health and safety will exhibit top management support and espouse corporate values that support their environmental and sustainability initiatives.

Having a small firm size helps to push a homogenous culture based on core values, yet 7G continues to find creative ways to ensure that the company structure is not too hierarchical to prevent employees from feeling connected with all its aspects (Seventh Generation 2007).

Employees are strongly encouraged to speak out their minds on business decisions made. 7G avoids the problems associated with unsuitable employees by carefully screening applicants and make sure they pass the competencies and values hurdles (Goldstein & Russo 2008).

A rigorous two-day training session acquaints new employees with corporate values, operating principles, organizational structure, and the health and environmental issues related to the products (Seventh Generation 2007). New hires also go through a comprehensive orientation program using an "on-boarding" process in the first year, subsequent retreats, education on the 7G brand, visits to manufacturer and retailer sites, and opportunity to earn a sabbatical for rendering community and philanthropic services (Seventh Generation 2008).

A notable turning point in the firm's culture was the across-the-board employee training in systems thinking led by consultant Carol Sanford in 2007. Nancy Stoddard, Vice President of Information Technology noted the following, "I've been seeing people working together cross-functionally --- people from sales and customer service and logistics and finance working together more closely and understanding each other's world much better. When there's someone who feels really strongly about something, I see people using 'the Law of Three,' one of the frameworks Carol taught us for shifting from a place of conflict to being able to reconcile to a higher purpose." (Seventh Generation 2007, p. 56).

"Systemic thinking" supports the business practice of ensuring employees cross departmental and hierarchical boundaries have a holistic view of 7G's activities through committee participation. Examples of such committees are the strategy team, operating team, steering committee, ERP team, product review team, product implementation team, Cyclops team --- cross-functional inventory/sales clearinghouse--- extension and evolution team, green team, work/life balance team, among others (Seventh Generation 2006).

Interaction with external stakeholders is also facilitated through a number of mechanisms: MPAR manufacturer audits supported by information technology-enabled extranet access; Sustainability Summit Conferences for the education and sharing of best practices with manufacturers; and active networking of 7G's top management in key local and international sustainability organizations. In dealing with critical stakeholders, the suppliers, 7G awards

contracts only to those who make the best offering in terms of performance, cost, sustainability values, geographic location, and accommodation for 7G's planned future product innovations (Seventh Generation 2008). 7G clearly exhibits the attributes of an organic organizational system that support the introduction of technological innovation.

These findings for the organizational context confirms the hypothesis that firms pursuing environmental and sustainability goals will use appropriate organizational mechanisms in order to achieve these goals.

6.3 Technological Context

Only selected steps in the technological context framework will be discussed here using the 7G case study. Data was available only for the steps discussed below.

1) Understand characteristics of the innovation (understand technical characteristics of innovation and social/technical context of subsystems)

7G was one of the key pioneer firms that have gone beyond the corporate stakeholders' interest in the financial bottomline as it took ownership of the social and ecological consequences of its business operations. The IT systems of 7G had to be designed within the context of the commitments of its corporate social subsystem. In keeping with its corporate values, 7G sought to manufacture household products from recycled or renewable materials made from nontoxic ingredients. Furthermore, 7G pursued operational activities with minimal environmental impacts.

7G used the tool that has a fairly broad following among firms committed to sustainability called "life cycle assessment" or LCA, a method used for determining the environmental impact of a physical product as it goes through the stages of raw material extraction, manufacturing, consumption, and disposal (Staib 2009). The International Organization for Standardization (ISO) has standardized the LCA methodology, which can be applied to products, materials, elements, or processes. LCAs are an expensive procedure to undertake and obtaining the needed data could be difficult. It is critical that accurate data is captured to render the final results and conclusions reliable.

2) Develop measures of implementation effectiveness (technical measures, social system measures, and organizational measures)

Effectiveness of 7G's sustainability efforts will be evaluated in terms of a number of criteria. Organizational criteria will be adjudged according to 7G's ability to meet its organizational goals and ensure the firm's survival. In this case, the key indicator that will be used is sales of 7G's cleaning products. 7G had its best year currently in 2008 when overall sales grew 51 percent from its 2007 numbers and when it partnered with 35 new retailers (2008 CCR). There has been a notable progressive increase in sales since 2006 when overall sales was up by 28 percent, followed by 45 percent in 2007 (Seventh Generation 2007, 2006). In 2009, performance was not quite as impressive due to the adverse effects of economic recession, however, mass merchandising sales grew by 24 percent and cleaning products remained the most popular product category as sales of dishwashing detergent grew industry wide (Seventh Generation 2009).

The implementation of Microsoft Dynamics NAV had contributed considerably to the successful performance of 7G's sales and manufacturing personnel. With more accurate and complete inventory data, sales personnel can provide better information to their manufacturing partners, warehouses, and customers --- thus, reducing both inventory aging and time-to-delivery. Inventory planning, logistics, and order processing have been streamlined (Microsoft Corporation 2008, December). Sales personnel are also now in the position to undertake "capable to promise" negotiations with customers when accepting orders. They can also undertake better planning for the execution of customer orders and delivering higher quality customer service.

Members of middle to top management of 7G are now empowered by the information generated by the overall system and are in a position to arrive at insightful solutions and data interpretations. Microsoft Dynamics NAV is a centrally managed solution that aggregates product, customer, and operational data, enabling a comprehensive view of the business. Data points that are usually of interest to top management include profitability by product and revenues generated by customer, vendor, and sales region, and environmental attributes by product, carbon footprint, etc. (Microsoft Corporation 2008, December).

Ultimately, 7G has enhanced its brand among its customers belonging to the environmentally aware market niche. 7G uses transparency through product descriptions and disclosure of product details pertinent to their contributions to the environment using the firm's website, which enables social networking tools such as links to Facebook, Twitter, MySpace, and LinkedIn. 7G also has an online community called 7GN Nation which encourages ongoing information and discussion about the experiences consumers have using 7G's products.

3) Plan and set pace of implementation (create technical plan; pace implementation; take social, organizational, and technical issues into account)

The technical plan that forms the foundation of the information systems support for 7G's sustainability focus is a combination of different approaches used to obtain the scientific chemical domain expertise needed to assess the ingredients used in the different products and environmental impacts of product packaging.

7G also uses the cradle to grave analysis method called the Life Cycle Assessment (LCA) to evaluate the processes involved in sourcing raw materials, manufacturing, packaging, transportation, distribution, use, and disposal (Ermgassen *et al.* 2010, May). 7G's new product innovation process employs strict development standards such as the use of ingredients that are vegetable derived, non-hazardous to the environment, biodegradable, phosphate free, chlorine free, not acutely toxic when used in a cleaning formulation, and not chronically toxic.

The LCA helped 7G analyze the greenhouse gases (GHGs) emitted at the key life cycle stages of its liquid laundry detergent in order to identify those stages that contribute the most to global warming (Hollender 2009). The analysis itself covers major impact categories, including surfactant manufacture, packaging, transportation, consumer use, and wastewater treatment. A key finding is that 96 percent of all the GHG emissions related to the manufacturing, use, and disposal of their liquid laundry detergent products occurred at the consumption phase by the end consumer. This is due to the use of warm or hot water in washing machines, which generated

enormous amounts of GHG. To reverse this situation, 7G not only substituted petroleum-based surfactants with plant-based surfactants, but changed the formulation of the product for cold water use (Hollender 2009). By 2009, the LCA analysis of 7G's baby wipe products was completed and two more product lines were scheduled for evaluation in 2010 (Seventh Generation 2009, 2008).

In 2007, the 7G project team used the "systems thinking" approach in planning their new ERP system (Seventh Generation 2007, p. 43). "With the different frameworks Carol [Sanford --- systems thinking consultant] had provided us to help us think holistically, we started on the outside and looked in. We asked ourselves what our customers needed and then backed our way through the value chain to see how we could add value to the whole process." (Seventh Generation 2007, p. 43). Nancy Stoddard, vice president of Information Technology noted that, "Previously, everyone would have had their functional hats on when it came time to select our ERP software. We might have ended up with a strong solution that was strong in tracking sales, for example, but weak on logistics. But we used Carol's systems-thinking frameworks and were able to look at the bigger picture and at the entire process. The dialogue switched from 'what my department needs,' to thinking as a business owner. When we finally chose a system, everyone was aligned to what was best for the whole company. The way in which our business information had been housed in the past was very fragmented, and it has been difficult to integrate different aspects of the business without significant manual work. The new system will be more efficient, flexible, and accommodating to growth." (Seventh Generation 2007, p. 43).

"We believe that business tools and business solutions can be used in more sustainable ways, and we want to be catalysts for making that happen," commented Julie Atwood, executive vice president of Finance & Administration. "When this new design is executed in 2008, we will begin to see some insights into important metrics. Traditional business systems might look at inventory and sales; we need to look for efficiencies that will help us reduce costs, while at the same time reducing our GHG emissions. It has been exciting to see us integrate systems thinking tools into our ERP scoping and design work." (Seventh Generation 2007, p. 43).

4) Install and integrate with the existing technical system (will include integration of social and technical considerations and involvement of affected stakeholders)

It has been previously mentioned that 7G had trained in the concepts of "systems thinking" under the tutelage of consultant Carol Sanford starting in 2006. After spending time with the methodology, 7G realized in 2007 that it needed to revamp its enterprise resource planning system (ERP) in order to build environmental management deeply in its core IT infrastructure.

They needed an ERP system that would improve supply chain management, automate business processes, and facilitate both internal and external collaboration with employees and trading partners. It was also clear to the staff that manual data entry in spreadsheets was largely inefficient and too time consuming for the kind of customer responsiveness and corporate social responsibility they were aiming for.

Ultimately, 7G decided to use the SCS Integrated Microsoft Dynamics NAV (MS Dynamics NAV) software package to meet its needs and the product was integrated by Microsoft Gold Certified Partner SCS, based in Santa Monica, California, with 7G's existing IT infrastructure which included Microsoft SQL Server@2005, the 2003 Microsoft Office system, Microsoft Exchange server 2003, and Microsoft Office Sharepoint Server@2007 (Microsoft Corporation 2008, December; PRNewsWire News Release 2008, January 29). Microsoft Dynamics NAV enables linkages among the following functionalities: manufacturing, supply chain management,

advanced warehouse management, shipping, customer relationship management, financials, and human resources management.

The new ERP system embodied in Microsoft Dynamics NAV was needed to support the following key functionalities: (1) product design and formulation: to track the raw materials and ingredients and manufacturing methods used by suppliers and vendors to ensure that only the safest inputs are used; (2) product packaging: to evaluate the nature of the materials used for packaging and identify their environmental attributes such as recycled content or environmental rating; and (3) carbon footprint tracking: to monitor and report on 7G's carbon footprint as it transports, distributes, and delivers its products (Microsoft Corporation 2008, December). MS Dynamics NAV not only provides the visibility of a product's environmental footprint, but also tracks the energy costs and other impacts from the time the product is manufactured at a remote partner's facility up to the time the product reaches the hands of the consumer. This complete tracking capability gives 7G the total greenhouse gas burden associated with each stage of the supply chain that a product goes through. Acting on the reports generated based on this data, 7G is in a better position to consider better alternative ingredients and raw materials and keep their costs down as well.

Other features of MS Dynamics NAV have direct implications for raising customer service satisfaction by streamlining order processing, inventory planning, and logistics. Real-time, accurate, and consistent inventory data now equips 7G employees to share reliable information with the firm's manufacturing partners, warehouses, and customers. Eventually, this contributes to reducing inventory aging, improving time-to-delivery, and enabling "capable to promise" ability when taking customer orders --- all critical aspects of delighting customers.

From a higher level perspective, these multiple MS Dynamics NAV features add up to benefit executives at different company levels by way of giving them a complete, comprehensive view of 7G's business at any point in time. Since the all related cross-functional business processes are now linked by the software and product, customer, and operational data are aggregated in a single, centrally managed solution, 7G employees can have current views of key datapoints: profitability by product, customer, sales region, and vendor, and the products' sustainability attributes as well.

7G has worked closely with its manufacturers to help them understand the firm's sustainability goals and to ensure that they are aligned with these goals. 7G does not manufacture its products and must rely on key manufacturing partners to perform this task. One key tool that 7G uses is its Manufacturing Partner Audit Program or MPAR initiated in 2006 (Seventh Generation 2009, 2008, 2007) to both qualify new manufacturers and evaluate existing manufacturers. Using MPAR, 7G engages its tier-one manufacturers on the firm's commitments and goals around environmental and social responsibility primarily through mentoring and educational efforts embodied in its annual Manufacturing Partners Sustainability Summit meetings.

In 2007, 7G started an audit of eight of its 10 key manufacturing partners. In 2008, 7G completed the audit started in 2007 of the same partners and added four more, and included environmental issues such as compliance, water pollution, energy use, waste management, and employee-related categories as well.

In terms of 7G's relationships with its customers, 7G has committed itself to educating its customers and ensuring an ongoing conversation with them as active participants in the continuous redesign and improvement of their products. 7G perceives its role as a proactive educator of consumers in the understanding and use of green products and moderator of what it hoped would be an active engagement of these stakeholders. Thus, in 2006 7G started blog

discussions with consumers using its inspiredprotagonist.com web site (Goldstein & Russo 2008).

And in 2008, demonstrating its commitment to transparency in order to gain and bind customer trust, 7G launched its “Show the World What’s Inside” initiative, which promotes full disclosure of ingredients used in all its products (Senge *et al.* 2010). Ingredient information in the form of “Material Safety Data Sheets” is posted in its website and also on an online “Label Reading Guide,” downloadable to consumers’ cell phones, designed specifically to help them interpret labels and make intelligent buying decisions at the point of purchase. While the U.S. Food and Drug Administration requires that a complete list of ingredients be listed in labels of processed food and personal hygiene care products, the same requirement is not enforced for house cleaning products. This only reinforces 7G’s commitment to preempt regulatory reporting requirements in favor of consumer health and protection. 7G also actively uses Web 2.0 tools and social networking to expand the reach of its consumer conversations.

To reach out to consumers even more extensively, 7G participates in a third-party website called GoodGuide.com that provides information to final consumers about 75,000 food, toys, personal care, and household products culled from both public and private databases. GoodGuide.com evaluates products primarily on three criteria --- health hazard assessment, environmental impact assessment, and social impact assessment using a number of scientific methods. The website currently uses a database that stores information on approximately 600 base criteria in evaluating products and firms. GoodGuide ratings are shown as data points in a scale of 1 (worst score) through to 10 (best score), representing a product’s performance compared with those of its nearest competitors. These ratings are also available to consumers at the point of purchase through an iPhone app.

These findings for the technological context confirms the hypothesis that firms pursuing environmental and sustainability goals will invest in appropriate information technologies to achieve these goals.

7. Conclusion and future research direction

Research results demonstrate that the data based on 7G’s experience supports the six propositions presented in this study. Furthermore, the environmental context as conceptualized within the TOE framework explains the impetus for the sustainability initiatives that have driven firms like 7G. The organizational context explains the adoption of different firm structural mechanisms used to facilitate the transition of the firm’s human resources to sustainability-based production and marketing business processes. Finally, the technological context illustrates how 7G undertook the implementation of an information system that supports its sustainability goals. Once a critical mass of firms across industries is found to be demonstrating corporate social responsibility through environmental sustainability, it would be feasible to conduct empirical research on the concepts embodied in the TOE framework. Relationships between appropriately operationalized TOE concepts and dependent variables like the firm’s economic performance, costs of supporting its green supply chain, customer satisfaction and loyalty, among others, could be tested.

References

(References will be provided upon request.)