

Sustainable Product Development

A Guide for Sustainable Entrepreneurs

SUSTAINABLE ENTREPRENEURSHIP PROJECT

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Sustainable Product Development: A Guide for Sustainable Entrepreneurs

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About the Project

The Sustainable Entrepreneurship Project (www.seproject.org) engages in and promotes research, education and training activities relating to entrepreneurial ventures launched with the aspiration to create sustainable enterprises that achieve significant growth in scale and value creation through the development of innovative products or services which form the basis for a successful international business. In furtherance of its mission the Project is involved in the preparation and distribution of Libraries of Resources for Sustainable Entrepreneurs covering Entrepreneurship, Leadership, Management, Organizational Design, Organizational Culture, Strategic Planning, Governance, Corporate Social Responsibility, Compliance and Risk Management, Finance, Human Resources, Product Development and Commercialization, Technology Management, Globalization, and Managing Growth and Change. Each of the Libraries include various Project publications such as handbooks, guides, briefings, articles, checklists, forms, forms, videos and audio works and other resources; management tools such as checklists and questionnaires, forms and training materials; books; chapters or articles in books; articles in journals, newspapers and magazines; theses and dissertations; papers; government and other public domain publications; online articles and databases; blogs; websites; and webinars and podcasts.

About the Author

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Sustainable Product Development

§1 Introduction

New and shifting legal, market and financial dynamics have increased the pressure on firms in manufacturing industries to implement processes for developing and marketing sustainable products. The environmental and social impacts of products and services depend on how they interact with the surrounding socio-economic and technical systems, sectors and actors along their life cycles. A number of actors need to be involved in the drive toward greater sustainability in the development, commercialization and use of products and services. Businesses, particularly larger and more established firms, can play a significant role in making changes in product design and functionality and then using their positions in the marketplace to communicate with customers and supply chain members about the importance of optimizing sustainability throughout the product life cycle. Consumers can also contribute by changing their preferences and decision making patterns to demand more responsibility with respect to environmental and social impacts in the products and services they purchase; however, changes in consumer attitudes require more investment in education and raising awareness. If consumers do show legitimate interest in sustainability, retailers need to exert pressure on their suppliers to develop and market sustainable product and service offerings and provide easily assessable information about those offerings to consumers. Media outlets must also be involved in disseminating information and providing opportunities for sustainable advocates and trendsetters to get their message out to consumers. Researchers in the corporate and academic communities must be able to provide the requisite technical innovations necessary for enhancing energy efficiency, reducing waste and pollution and eco-design.

§2 Business approaches for sustainable products

Since product developers and designers are the generally the first ones to conceptualize how, and of what materials, a new product will be manufactured, they have a strong influence on the environmental impact of the product during its life cycle. In fact, the National Research Council has estimated that approximately 70% of the costs associated with a product's development, manufacture and use (i.e., its life cycle) are determined in the initial design stage.¹ Among other things, product developers and designers play a leading role with respect to specification of raw materials, energy inputs, purchasing specifications, hazardous materials generated, recycling and worker health and safety.² However, environmental performance is just one of the business goals for product developers and they must balance environmental impact against other priorities such as regulatory compliance, product performance, consumer acceptability, and price.³

¹ Designing Products and Services with Sustainable Attributes: An Internal Assessment Tool for Product Developers (Grand Rapids, MI: The Design Work Group West Michigan Sustainable Business Forum, 1999), 2.

² Id. at 3.

³ Id. at 4.

Companies have used a variety of analytical tools and managerial processes and strategies as part of their business approaches to developing sustainable products and services.⁴ Among the more popular analytical tools have been lifecycle assessment (“LSA”), lifecycle costing, risk assessment, environmental impact assessment, ecological footprint and MIPS for systematic evaluation of environmental impacts along the entire supply chain or product lifecycle. Managerial processes and approaches have included eco-design, eco-innovation, product service systems (i.e., selling a bundle of products and services based on functionality rather than purely physical products), lifecycle management, product stewardship, supply chain management, corporate social responsibility and product-oriented environmental management systems that are used to collect and analyze lifecycle information. Lifecycle management and product stewardship are particularly important for integrating lifecycle thinking into the corporate culture and structure and product design and encouraging communication with customers, product marketing, information and support.

§3 --Sustainable product and service development

Maxwell and van der Vorst wrote about their efforts to develop a method that would provide a framework for implementing sustainable product and/or service development (“SPSD”) throughout the entire lifecycle of a product and/or service. They noted that the product and/or service lifecycle starts at conception, where there is only a concept and design of a potential product or service, and then continues with raw materials, production processes, distribution, consumption and “end of life” as well as potential “recovery” and “reuse” options (e.g., production processes, consumption and/or “end of life” back to raw materials).⁵ They defined and described SPSP as follows:

“SPSD is defined here as the process of making products and/or services in a more sustainable way throughout their entire lifecycle, from conception to end of life. The products and/or services are developed to be more sustainable in a Triple Bottom Line (TBL) context, i.e. balancing economic, environmental and social aspects. This is interpreted as achieving an optimum balance between environmental protection, social equity and economic prosperity, while still meeting traditional product requirements, e.g. quality, market, technical and cost issues, etc. The goal of SPSP is to produce products and/or to provide services, which are sustainable and achieve their required functionality, meet customer requirements and are cost effective. In other words, SPSP is about producing superior products and/or services that fulfil traditional criteria as well as sustainability requirements.”⁶

⁴ United Nations Environment Program, The Marrakech Process: Sustainable Products, https://esa.un.org/marrakechprocess/pdf/Issues_Sustainable_Products.pdf

⁵ D. Maxwell and R. van der Vorst, “Developing Sustainable Products and Services”, *Journal of Cleaner Production*, 11 (2003), 883, 885.

⁶ D. Maxwell and R. van der Vorst, “Developing Sustainable Products and Services”, *Journal of Cleaner Production*, 11 (2003), 883, 884.

Maxwell and van der Vorst pointed out that SPSD represented an evolutionary step in approaches to sustainable product development in that it went beyond the traditional emphasis on reducing the environmental impacts of products to incorporate services as well as products and all of the TBL elements. Another important aspect of SPSD was the incorporation of the “Product Service Systems”, or “PSS”, concept, which is described in more detail below and involved “shifting the focus of the design away from producing products to providing a function and determining whether the function can be provided by a service, a product or some combination of a PSS”.⁷ PSS provide companies with opportunities to reduce the volume of products that they manufacture, which also has environmental benefits, and increase profits through the introduction of services offerings. For example, when Xerox transitioned from manufacturing photocopiers to being the “Document Company”, it began offering “functions” through a PSS approach (i.e., offering a product which incorporated service elements such as product leasing, upgrade and maintenance to provide the required functionality more effectively).⁸

Maxwell and van der Vorst explained that “SPSD is about assessing the lifecycle of a function to be provided (from conception to end of life) and determining the optimum sustainable (environmental, social and economic) way of providing that function (through a product, service or PSS) in line with traditional product and/or service criteria”.⁹ The first step of the SPSD process occurs at the “concept stage” when a determination is made about the best way to meet the functional requirements. At this point, the relevant question is whether functionality can be provided through a product, a service or some combination of a PSS and then optimizing the sustainability impacts of these options with traditional criteria. Once a decision has been made about whether a product, service or PSS is to be developed, the relevant life cycle stages (e.g., raw materials, production process, distribution, consumption and “end of life”) and the associated supply chain should be identified. Maxwell and van der Vorst pointed out that a key element of SPSD was its focus on the supply chain for the product and/or service rather than solely at an individual company level, and an assessment must be made of the entire supply chain to determine which companies are the optimum targets for SPSD implementation and how supply chain management (“SPM”) can be effectively utilized. Particular emphasis should be placed on those supply chain companies that have control over the main life cycle phases with key sustainability issues. The next step is an assessment of the environmental and then social impacts for each product or PSS life cycle stage to identify opportunities for elimination or minimization of these impacts which can be optimized with the remaining traditional product and service criteria.

⁷ Id. at 885 (citing E. Reiskin, A. White, J. Kauffman and J. Votta, “Servicizing the chemical supply chain”, *Journal of Industrial Ecology*, 2000:3, 2; and O. Mont, “Lessons from the transitions towards product-service systems in Swedish companies: reflections and methodologies” in *Proceedings of Sustainable Services and Systems: Transition towards Sustainability? (Towards Sustainable Product Design No. 6, The Netherlands, October 29–30, 2001)*, 184).

⁸ Id.

⁹ Id.

Based on their research relating to sustainable product development, Maxwell and van der Vorst identified the following key framework features for ensuring effective SPSD implementation in industry¹⁰:

- Use of a strategy level approach, which should be integrated into existing corporate business, sustainability/environmental systems and product development systems.
- Use of a simple, flexible, non-resource intensive approach designed to mesh with the business reality.
- Integration and optimization of TBL criteria with traditional product and service specifications over the entire product life cycle.
- Determination of the requirement for a product based on the functionality and consideration of the options for PSS.
- Use of Supply Chain Dynamics (“SCD”) to determine the most effective target supply chain company(ies) for SPSD implementation and for effective SCM up and down the supply chain.

§4 ----Strategy level, integrated approach

According to Maxwell and van der Vorst, research indicated that incorporating SPSD as a core element of the business strategy, rather than maintaining “sustainability” as a standalone program, is necessary for corporate commitment and is more effective for cascading SPSD throughout the company’s activities.¹¹ Once “producing sustainable products and services” becomes a core business criterion it can be incorporated into all other business functions (e.g., product development, production, finance, marketing, public relations, purchasing, quality assurance, health and safety and environmental and social management) for overall sustainability performance improvement. It is particularly important to incorporate SPSD into the company’s product design and development approaches, since this makes it easier to incorporate sustainability criteria into the other functions that traditionally feed into product development such as production, purchasing, quality assurance and finance. SPSD is also an obvious compliment to effective environmental and social management initiatives.

§5 ----Simple, pragmatic approach

When applying SPSD, Maxwell and van der Vorst recommended that companies take a simple, qualitative, pragmatic and flexible approach that is in line with the realities of the business in which the company is operating and the company’s existing business and product strategies.¹² They also cautioned companies not to implement SPSD in a way that was overly resource intensive in terms of time, cost or personnel especially in light of the typically short time span from product concept to market.

§6 ----Integration and optimization of the Triple Bottom Line

¹⁰ Id.

¹¹ Id. at 887.

¹² Id.

Maxwell and van der Vorst noted that “eco-design” as it had been practiced in the past failed to simultaneously optimize social, ethical and economic issues.¹³ They explained that if sustainability was the goal, it could not be achieved simply by reducing the environmental impact of a product using an eco-design approach and that in order to integrating sustainability into product and service development companies needed to adopt SPSPD and its explicit integration of sustainability in the form of “triple bottom line” considerations with traditional product criteria. Maxwell and van der Vorst emphasized that the criteria for optimizing sustainability in products and services should include economic impacts, quality, market demand, customer requirements, technical feasibility, compliance issues (i.e., compliance with legislation and industry/technical specifications), environmental impacts, social impacts and functionality.

Consideration of Triple Bottom Line Issues in Sustainable Product Development

Maxwell and van der Vorst developed a checklist to guide consideration of “triple bottom line” issues during the development of a sustainable product and/or service (“SPSPD”). The questions on the checklist were organized by reference to the specific SPSPD criteria (i.e., functionality, environmental impact, social impact and economic aspects) and the stage in the product life cycle (i.e., raw materials, conception, production, distribution, consumption and end of life) where an issue was typically most relevant.

SPSPD criteria: Optimize functionality

Conception stage

- What is the functionality?
- How can this be achieved?
- Do you need a product?
- Could this be achieved by a service?
- Options for PSS?

SPSPD criteria: Optimize environmental impact

Raw materials stage

- Reduce the volume of materials used (dematerialization)
- Nature of raw materials
- Eliminate or reduce non-renewables usage
- Substitution of none/less hazardous raw materials
- Facilitate recovery, reuse, recycling
- Extraction and processing of raw materials
- Transport from supplier

Production stage

- Optimize production technology
- Eliminate/reduce emissions to air
- Eliminate/reduce effluents
- Eliminate/reduce waste
- Eliminate/reduce energy usage

¹³ Id. at 888.

Distribution stage

- Is transport necessary?
- Volume and nature of transport
- Type of fuel usage
- Eliminate/reduce emissions to air
- Eliminate/reduce waste

Consumption stage

- Eliminate/reduce waste from product
- Eliminate/reduce waste from packaging
- Eliminate/reduce energy consumption

End of life stage

- Extend product life
- Design for repair
- Modular design for maximizing upgradability
- Facilitate recovery of components for reuse
- Facilitate recovery of components for recycling and treatment/disposal

SPSD criteria: Optimize social impacts

Raw materials stage

- Are the raw materials extracted and/or processed in the developing world?
- Ownership rights
- Are the trading arrangements equitable?

Production and distribution stages

- Employee conditions of work at company
- Employee conditions of work in subcontract companies
- Impact on local community
- Investment in local community

Consumption stage

- Adverse health/safety impacts for the local community
- Adverse health/safety impacts for the global community

End of life stage

- Adverse health/safety impacts for the local community
- Adverse health/safety impacts for the global community

SPSD criteria: Optimize economic aspects

All stages

- Is the product and/or service cost effective?
- Does the product and/or service cost the same/less than competing versions?
- Are environmental externality costs (e.g. end of life recovery, reuse/treatment/disposal) taken into

account?

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Source: D. Maxwell and R. van der Vorst, “Developing Sustainable Products and Services”, *Journal of Cleaner Production*, 11 (2003), 883, 892-893.

§7 ----Determination of product requirements and consideration of PSS options

Maxwell and van der Vorst acknowledged efforts to use “de-materialization” (i.e., reduction or complete replacement of material and energy inputs into a product) as a means for reducing adverse environmental impacts of products, but pointed out that it was difficult to achieve complete de-materialization and still achieve the desired functionality for the finished product.¹⁴ In their view, companies could achieve both environmental and commercial benefits through consideration of PPS options that decoupled volume (i.e., producing lots of products) from profitability and focused on the functionality (i.e., producing less product and managing it better as a PSS). PSS options allow companies to focus on functionality as their value proposition and achieve various environmental benefits such as a reduction of raw materials and in the volume of products produced, increased de-materialization of products and reduced energy usage and waste generation due to the reduced volume of products produced as well as the eco-efficiencies introduced into the production process.¹⁵ Maxwell and van der Vorst argued that PSS also provides opportunities for social impacts through the creation of new jobs associated with the services that are introduced to replace products.

§8 ----SPSD and the product supply chain

Maxwell and van der Vorst observed that as of the time they wrote their article on SPSP most of the approaches to sustainability impacts of products, such as eco-design, had focused on individual companies irrespective of their role in the supply chain and the wider product supply chain dynamics.¹⁶ They argued that in order to effectively reduce the sustainability impacts of products, the supply chain aspect of product manufacture needed to be incorporated since most products with significant sustainability impacts, such as automobiles and electronics goods, were produced with input from a number of companies in a supply chain. Maxwell and van der Vorst recommended that companies target those members of the relevant supply chain with control over the product life cycle stages where most of the sustainability issues associated with the product can be effectively tackled, which usually means the activities during the product conception and design phases. They believed that such an approach would be effective regardless of the size of the company developing the finished product and that the SPSP approach can and should be spread out to other organizations involved in the supply chain either upstream or downstream as relevant mainly in the form of product specifications.

§9 --Product service systems

¹⁴ Id.

¹⁵ Id. at 889.

¹⁶ Id. at 889-890.

Product service systems (“PSS”) have been described as an innovation strategy that not only brings the benefits of de-materialization, but also opens up new markets and improves competitiveness.¹⁷ Since the producer retains product ownership when the PSS approach is used it has more incentives to lower costs of ownership per unit of product function and this translates into motivation for the product to implement mechanisms to recover the rest value from recycling of material and energy content. From the consumer’s perspective, the access to new and more flexible service packages associated with PSS provides more value added than traditional models based on product ownership. Examples of de-materialization based on the PPS concept include integrated pest control services (Koppert), launderette services (Electrolux), copier leasing (Océ, Xerox), carpet leasing (Interface), industrial lubrication (SKF), electronics refurbishment programmes (Sony), network computing and application service provision (HP, Intel, ChipPC) and flexible office (Gispen).¹⁸

§10 Role of governments and multinational organizations

An analysis of the life cycles of 283 product groups by the Institute for Prospective Technological Studies in 2006 concluded that the products with the highest environmental impact related to final consumption among the countries in the European Union could be found among food and drink, passenger transport, housing and utilities, healthcare, communication and recreation.¹⁹ While presumably firms operating in these sectors would proactively explore and embrace sustainability in the product development efforts, the reality is that the economic rationale and market forces have often been ineffective in improving the environmental and social performance of products. In general, “green” products continue to be perceived as niche markets and companies often do not feel any pressure to increase sustainability in their product lines due to lack of consumer awareness and demand. In response to these market failures, policy makers have begun to intervene by introducing measures that create a climate favorable to environmental and social business innovation and stimulate demand for sustainable products. However, the challenge for governments and multinational organizations has been to find the optimal set of measures and the right actors in supply chains that are most capable to induce changes with the utmost economic efficiency and environmental and social effectiveness. Among the most commonly used policy instruments and initiatives for sustainable products are the following²⁰:

- **Substance bans:** Policies targeting hazardous substances such as CFCs, POPs, heavy metals in electronics and others have proven to be effective in reducing product toxicity. Policies placing responsibility for waste management on producers have improved end-of-life management and encouraged innovations in packaging, eco-design, material substitution and de-materialization.

¹⁷ United Nations Environment Program, The Marrakech Process: Sustainable Products, https://esa.un.org/marrakechprocess/pdf/Issues_Sustainable_Products.pdf

¹⁸ Id.

¹⁹ United Nations Environment Program, The Marrakech Process: Sustainable Products, https://esa.un.org/marrakechprocess/pdf/Issues_Sustainable_Products.pdf

²⁰ United Nations Environment Program, The Marrakech Process: Sustainable Products, https://esa.un.org/marrakechprocess/pdf/Issues_Sustainable_Products.pdf

- **Performance standards:** A number of countries have implemented performance standards relating to energy efficiency for various products such as electrical appliances.
- **Labeling schemes:** Eco-labels have proven to be an effective tool to communicate the environmental properties of sustainable products and have been shown to be successful in improving the level of consumer awareness and marketing efforts relating to such products. Eco-labeling has become standardized (e.g. ISO 14020 Type I, II and III frameworks) and certain eco-labels, such as the Energy Star, have achieved international recognition and been a significant driver of innovation with respect to IT and office equipment, residential appliances, lighting, heating and cooling equipment, as well as new buildings. The social dimension of sustainability has been addressed by labeling material origin or ethics of production (i.e., “Fair Trade labeling”).
- **Producer responsibility regulations:** Many countries have implemented producer responsibility regulations to address social responsibility issues such as child labor, poor working conditions and unfair wages. These regulations have been accompanied by business initiatives launched by companies seeking to promote socially responsible production models and fair distribution of revenues among producers in poor countries (i.e., the “Fair Trade” initiative).
- **National and international initiatives:** National initiatives have been launched to encourage investment in the development and diffusion of new technologies to shift energy usage away from traditional environmentally harmful sources to alternatives such as wind and solar power. Initiatives in developing countries have focused on greening forestry (e.g., sustainable foreign management certification), agricultural products and local community benefits, and developed countries have provided assistance to developing countries to promote investment in energy efficient products.

While there are numerous opportunities for innovation and potential competitive advantage in sustainable product development, companies often encounter significant challenges beginning with the lack of adequate financing due to the perception among investors that environmental and social innovation remains a highly risky proposition. Market failures in the private sector with respect to financing have placed additional pressure on governments and venture capitalists to provide support for research and development and product design and commercialization relating to sustainable products. Additional work needs to be done to ensure that breakthroughs in academia are communicated into the commercial sector so that research done and intellectual property created in university labs can be leveraged to reduce transactional costs for companies commercializing sustainable products. Governments can also ease the process for sustainable process to gain acceptance in the marketplace through information campaigns to inform consumers about products and the benefits of new lifestyle habits in which goods are perceived and consumed differently. In addition, governments must support and execute policy initiatives that highlight the importance of energy efficiency and climate change measures. Finally, more progress needs to be made in harmonizing performance standards and methods for measuring and reporting the sustainability of

products and services including better metrics for assessing social responsibility issues such as education, fair trade, child labor and labor rights.²¹

Case Study: Developing Responsible Products and Services

The website of CAA-Quebec, a not-for-profit organizational successor to the Canadian Automobile Association, touts the organizations mission to provide all of its members with peace of mind by offering them high-quality automotive, travel, residential and insurance benefits, products and services. A section of the website, “Developing Responsible Products and Services”, provides an interesting and diverse list of ideas that could be adopted by other organizations in their efforts to integrate sustainability into their products, services and operational processes:

- Acquisition of a driving simulator: Offices of the organization include technologically advanced devices that provide many demonstrations to members in complete safety without consuming fuel.
- Participation in the creation of a provincial network for the inspection of child safety seats: A permanent network enabling parents in Quebec to find a resource for ensuring that their child is safe aboard the family vehicle
- Creation of the CAA-Quebec Foundation: An entity separate from CAA-Quebec with the mission of promoting research and education aimed at improving road safety.
- Bringing hybrid vehicles into the CAA-Quebec fleet: Purchase of hybrid vehicles to reduce fuel consumption and environmental impact of travel activities of organization employees.
- Reduction in paper use and increased use of recycled paper : Replacement of the paper editions of various publications; implementation of e-ticket issuance services at travel agency centers and priority given to paper made from 100% recycled post-consumption fibre (FSC paper, mainly from Quebec).
- Putting electronic tools for sustainable mobility online: Providing website visitors with a basic guide to climate change, eco-choice calculator, eco-mobility and user costs.
- Availability of biodegradable and reusable bags: The bags that are given to members are biodegradable; CAA-Quebec also offers its own version of reusable bags for sale.
- Promotion of ecological and energy-efficient solutions: Publication of various information tools (*Touring* magazine, e-bulletins, caaquebec.com, etc.
- Compliance with the ISO 9001 standard at the two CAA-Quebec inspection centers: Ensures members and the public of compliance with the top standards of quality and service.

Source: CAA Quebec, Developing Responsible Products and Services, <https://www.caaquebec.com/en/about-us/a-responsible-citizen/sustainable-development/developing-responsible-products-and-services/>

²¹ United Nations Environment Program, The Marrakech Process: Sustainable Products, https://esa.un.org/marrakechprocess/pdf/Issues_Sustainable_Products.pdf

References and Resources

The Sustainable Entrepreneurship Project's Library of Resources for Sustainable Entrepreneurs relating to Product Development and Commercialization is available at <https://seproject.org/product-development-and-commercialization/> and includes materials relating to the subject matters of this Guide including various Project publications such as handbooks, guides, briefings, articles, checklists, forms, forms, videos and audio works and other resources; management tools such as checklists and questionnaires, forms and training materials; books; chapters or articles in books; articles in journals, newspapers and magazines; theses and dissertations; papers; government and other public domain publications; online articles and databases; blogs; websites; and webinars and podcasts. Changes to the Library are made on a continuous basis and notifications of changes, as well as new versions of this Guide, will be provided to readers that enter their names on the Project mailing list by following the procedures on the Project's website.

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