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# Business modelling for sustainable manufacturing

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**Abstract:** The paper proposes a business modelling process for manufacturing firms to assist them in integrating sustainability into their business model. The process consists of four steps. Expected outputs and questions, driving the analysis and decisions carried along the process, are also included in each step. The proposal is grounded on the state of the art review and a state of practice review done through six exploratory case studies.

**Keywords:** business model, business modelling, sustainable manufacturing, value creation, sustainability.

## 1 Introduction

The changing business landscape, influenced by the increasing awareness of environmental and social impact of industrial activities, is addressing new challenges that stimulates an on-going transformation process leading towards a sustainable industrial system (Evans et al. 2009). Hence, a broader vision for Sustainable Manufacturing has been suggested in the recent years by many authors. A comprehensive definition reflects on Sustainable Manufacturing as *‘the ability to smartly use natural resources for manufacturing, by creating products and solutions that, thanks to new technology, regulatory measures and coherent social behaviours, are able to satisfy economic, environmental and social objectives, thus preserving the environment, while continuing to improve the quality of human life’* (Garetti and Taisch, 2012). However, understanding of the term ‘sustainability’ still varies significantly between manufacturing firms. Some consider mere compliance with environmental legislation to be sustainability; others see waste and cost reduction, or reduction of carbon emissions as sustainability; others view workplace and employee rights or community engagement as sustainability (Bonini et al. 2010). Willard (2005) proposes a ‘corporate sustainability continuum’, through which firms’ progress on the path towards sustainability. Walking along this path will imply changes in the firms that will affect several aspects of their organisation, thus an important innovation process could take place in order to integrate sustainability in the core purpose of the firm, i.e. in their business model.

This integration will need to address two main issues: (i) the value created by the firm should not be only considered in economic terms, hence there is a need for a more holistic view that integrates social and environmental goals (Schaltegger et al. 2011); (ii) from a network perspective, the scope of value needs to include a wider range of stakeholders in a much more explicit manner that involves relationships, exchanges and interactions, besides just economic transactions (Allee 2011). This paper makes a proposal to this end. After a state of the art review from literature, a state of practice review is presented (section 2): based on their key findings, the methodology for the development of the business modelling process is shortly highlighted (section 3) and the process itself is described (section 4). A discussion is eventually proposed (section 5), to compare our proposal with other processes in literature and to raise the debate on the issues still open in the research agenda.

## **2 Review in business modelling**

### **2.1 State of the art review**

The term business model (BM) is widely used in academic and business literature (Richardson, 2008; Zott et al., 2011; Lee et al., 2011). Although there is a general agreement on its basic definition, considered as a simply description of how a firm does business (Richardson, 2008), there is still not theoretical grounding in economic or business studies about this concept (Teece, 2010). BMs have diverse utilities within a firm, such as being a design of the value proposition, creation, delivery and capture mechanisms (Teece, 2010, Osterwalder and Pigneur, 2010) and being a source of innovation (Zott and Amit, 2007, Teece, 2010, Ludeke-Freund, 2010).

Authors such as Chesbrough and Rosenbloom (2002), Braet and Ballon (2007), Richardson (2008), Zott and Amit (2010), Teece (2010), Osterwalder and Pigneur (2010) and Romero and Molina (2011) are key authors in business modelling literature, who have attempted either to describe a business modelling framework or a process. Although without a particular focus on sustainability, their contributions provide a useful overview of the current state of art. Concrete contributions to sustainability-oriented BMs are made by Stubbs and Cocklin (2008), Ludeke-Freund (2010) and Tukker and Tischner (2006), the latter having a focus on Product-Service-System (PSS) as a concrete type of BM. Table 1 summarises their main contributions in terms of what is distinct or novel, that can be (potentially) associated to sustainable business modelling.

As can be deduced from the table, the literature, although comprehensive, is limited in defining and illustrating a business modelling process. The processes primarily guide thinking in generating economic value and do not explicitly embed or consider environmental and social concerns and benefits, nor analyse or include a multi-stakeholder view. Nonetheless, a range of business modelling frameworks is presented that offer a good starting point for developing a business modelling process. The Osterwalder and Pigneur canvas seems the preferable framework for its adaptation to sustainable business modelling: it covers the dominant elements discussed in

literature even if, being aligned to what literature is lacking, it is focused on generating economic value and has limited stakeholder inclusion (limited to customer and immediate partners). Governance structure and corporate norms & values are observed – within frameworks – to be important for driving sustainability into BMs. Key authors in literature have tried to describe a business modelling process, as presented in table 1. However these descriptions are still at a conceptual or exploratory phase, while not much is written about being used in practice. The main drawbacks for sustainable business modelling is the difficulty in embedding sustainability into BM elements and ambiguity in the definition of sustainable BM concept.

Authors	Framework	Process
Chesbrough and Rosenbloom, 2002	A framework that embodies strategy and financial modeling and remarks importance of value creation among core company and third parties	---
Tukker and Tischner, 2006	---	A process as a methodology for PSS development under a sustainability-based approach
Braet and Ballon, 2007	---	A process as a cyclic approach; main element of the approach is the categorization of the actors and roles that are active in a given value network
Richardson, 2008	A framework organized around the concept of value; main elements are: value proposition, value creation and delivery and value capture	---
Stubbs and Cocklin, 2008	A framework for analysis consisting on structural and cultural attributes of sustainable BMs	---
Teece, 2010	---	A process with emphasis on value proposition and mechanisms for value capture, focusing primarily on customers and referring exclusively to long-term economic sustainability
Zott and Amit, 2010	A framework with a broader understanding of value creation through interactions along the value network; main elements are: content, structure and governance	---
Lüdeke-Freund, 2010	A conceptual framework oriented to sustainability strategies driven by eco-innovations and focused on creating an extended customer value	---
Osterwalder and Pigneur 2010	A framework (named as canvas) proposing a set of elements for the design of BMs: customer segments; value proposition; channels; customer relationships; revenue streams; key resources; key activities; key partnerships; cost structure	A business design process made of 5 phases: Mobilize, Understand, Design, Implement and Manage
Romero and Molina, 2011	A framework providing a multi-value system perspective; multi-stakeholder approach; the role of the customer in the co-creation process	---

**Table 1.** Review of frameworks and processes in business modelling

To sum up, the literature is lacking many sustainability related issues, primarily: (i) the integration of a broader range of stakeholders in business modelling, understanding how value might be perceived for them; (ii) a process for exploring other forms of value, rather than solely economic one, and for analyzing related relationships, exchanges and interactions.

## 2.2 State of practice review

This section provides the results of the state of practice reviewed through 6 case studies spread across norm to extreme examples of sustainability, where norm represents an incremental approach to sustainability innovation, and extreme represents a firm

seeking to introduce radical change. A semi-structured interview approach was adopted to explore the current practice in the selected cases. Table 2 highlights the results for the norm cases: three cases (case A, C, D) are multinational companies, one is a start-up (case B). Table 3 highlights the results for the extreme cases: one is a start-up (case E), one is a SME (case F). The factors under analysis are: the key drivers for sustainability initiatives (row number 1); the BM innovation processes employed (row number 2); the value network perspective (row number 3).

	A (Food & Agriculture)	B (Laundry equipment)	C (Printing & copying equipment)	D (Food & Agriculture equipment)
1	Economic motive + climate change + resource limitations	Technology innovation + Customers' increasing awareness of energy and water costs	Economic motive + resource efficiency + customer demand for low cost of ownership	Productivity and sustainability of agricultural land + fuel & time efficiencies
2	Focus on frugality – efficiency + waste reduction and reuse + formal process for assessing sustainability dimensions of new business initiatives + stakeholder mapping	Technology led firm + little focus on BM, no focus on sustainability per se	Little formal focus on BMs or sustainability per se	PSS as strategic add-on to the core product business + various strategy tools employed to consider customer demands, pricing and distribution channels
3	Close relationship with growers in supply chain + engagement with local communities around the growers + B2B	Relationships with trial partners for technology development + Partnerships with university for R&D + Focus on developing licensing to major manufacturers	Distributors and resellers + Employees recognized as key resource to the BM	Suppliers of major mechanical systems and software solutions + some wholly-owned distributors and network of other dealers and importers + relationships with customers through employees

**Table 2.** Review of business modelling process in practice – norm

	E (Personal transportation)	F (Home and Office Furniture)
1	Perceived need for environmental friendly personal mobility solution	Resource efficiency + long-term view of value optimization for the customer and the environment
2	Systematic innovation process + iterative redesign for optimization + current tools available not considered particularly helpful	Little formal development of business modelling for sustainability + ad-hoc process of business improvement
3	Network of suppliers for technology, hydrogen infrastructure + local council partners for programme roll-out	Removed intermediaries from distribution network for closeness to customers + Local manufacturing strategy + employees as key resource + Strong ties with customers & suppliers through financing structure + potential for turning firm into employee owned

**Table 3.** Review of business modelling process in practice – extreme

Followings are the overall findings of the state of practice review.

- Business modelling often has an organic/ad-hoc approach depending on radical leadership rather than tools and techniques.
- Sustainability is seen more as a detached or isolated concept with difficulty in embedding it in the business purpose and processes.
- Within the stakeholders discussion, their interactions and understanding of value are minimal given the dynamic and complex structure of value networks.
- Governance structure influences whether or not sustainability is successfully incorporated.

### 2.3 Research Gap

The literature and practice review highlights a need for innovation in business modelling process that will assist manufacturing firms in developing and enhancing their BMs to embed sustainability. The existing knowledge in BM development is focused on generating only economic value. To extend the construct of value to include environmental and social benefits through a multi-stakeholder view, a substantial change in the way business are conceived and operated is required. Hence, this paper proposes a business modelling process that assists firms in embedding sustainability into their business, exploring other forms of value (social and environmental) and analysing value exchanges.

## 3 Methodology

The literature and practice reviews on business modelling contributed to the initial development of the proposed business modelling process. Afterwards, the development went through further iterations involving brainstorming sessions, meetings and two exploratory workshops with research and industrial partners. It further involved reviews of EU and international projects and reports and researchers working on other knowledge areas (sustainable manufacturing, value networks) were considered for idea generation and discussion.

## 4 Proposed business modelling process

The business modelling process herein proposed provides a multi-stakeholder view, shared-value creation with different perspectives on value and explicit consideration of environment and society as main elements for developing a sustainable BM. The business modelling process is composed of four steps. Table 4 introduces the description of each step. At the end of the process, it is required to build the governance structure for supporting BM implementation. In particular, the governance structure aims at providing better ways to manage, measure, monitor and control the business activities; hence, it would act as a support for the effective incorporation of sustainability in the BM.

	STEP	DESCRIPTION
1	Purpose of the business	This step attempts to clarify the business concepts in order to go on along next steps, understanding the strategic objectives and firms' position towards sustainability; in particular, it aims at discussing business concepts such as products & service bundles, sustainability values, industry-related needs and opportunities.
2	Identify potential stakeholders and select sustainability factors	This step aims at identifying (i) the potential stakeholders within the business ecosystem and what they do value and (ii) the sustainability factors leading decisions
3	Develop the value proposition	This step pursues to envision the value proposition for a firm and its stakeholders
4	Develop the value creation and delivery system and the value capture mechanism	This step aims at developing the value creation and delivery system and the value capture mechanisms by defining in particular the key activities, key resources, key partners, key channels, key mind-set and the value exchanges for the firm and its stakeholders

**Table 4.** Business modelling process – description of the steps.

Table 5 presents the four steps of the process identifying the expected outputs as well as several questions that would drive their achievement, as well as the analysis and decisions at each step.

	STEP	EXPECTED OUTPUTS AND QUESTIONS AT EACH STEP
1	Purpose of the business	<p><i>Concept of industry, products and services bundle, sustainability values (higher level thinking), idea generation/starting point</i></p> <ul style="list-style-type: none"> <li>• What are the reasons the firm is in business?</li> <li>• Which is the firm's approach towards sustainability?</li> <li>• What are the trends, emerging technologies, opportunities and drivers for the firm's context? (opportunities and drivers for environmental and social sustainability)</li> </ul>
2	Identify potential stakeholders and select sustainability factors	<p><i>Stakeholders type, what are they interested in and which sustainability factors are important to them?</i></p> <ul style="list-style-type: none"> <li>• Who are the possible stakeholders?</li> <li>• What is of value to each stakeholder?</li> <li>• What sustainability factors are important to them?</li> <li>• What are the factors that will drive the firm's decision?</li> </ul>
3	Develop the value proposition	<p><i>Value proposition for a firm and its stakeholders</i></p> <ul style="list-style-type: none"> <li>• What are the value opportunities for the firm? What is(are) the potential value exchange(s)?</li> <li>• What happens if the firm pushes beyond compliance of current accepted standards?</li> <li>• What are the negative potentialities associated to the offering? How can they be eliminated or mitigated?</li> <li>• How can positive social and environmental value be enhanced?</li> <li>• What is the firm's offering – products and services, tangible and intangible benefits – to each stakeholder?</li> </ul>
4	Develop the value creation and delivery system and the value capture mechanism	<p><i>Key activities, key resources, key partners, key channels, key mindset. Definition of the value exchanges and value capture for the stakeholders.</i></p> <ul style="list-style-type: none"> <li>• How is value created and delivered to the identified stakeholders?</li> <li>• What are the activities, resources, suppliers/partners and the relationships with them, network configuration, channels and mind-set?</li> <li>• What are the value exchanges for the firm and the stakeholders?</li> <li>• How is the economic value captured?</li> <li>• How does the firm capture value from public value (environmental and social) creation?</li> <li>• How does other stakeholders capture value?</li> <li>• Is the business model economically, environmentally and socially viable?</li> </ul>

**Table 5.** Business modelling process – steps, expected outputs and questions

## 5 Discussion

### 5.1 Comparison with other business modelling processes

This section presents a comparison between our proposed business modelling process and other processes from the literature review<sup>1</sup>. Table 6 shows the steps compounding each process as well as, in the bottom part of the table, their sustainability approaches. It should be noted that our proposal emphasises a comprehensive vision of value (including economic, environmental and social aspects) and a broader multi-stakeholder perspective along all the steps. Another advantage is that it does not address any concrete type of BM, remaining then applicable for a higher variety of firms.

<sup>1</sup> Braet and Ballon, 2007 were not included in the table as they did not develop a process based on steps but a cycle with four phases (Organization, Technology, Service and Financial)

	<b>Our proposed business modelling process</b>	<b>Tukker and Tischner, 2006</b>	<b>Teece, 2010</b>	<b>Osterwalder and Pigneur, 2010</b>
1	Purpose of the business	Analysis on PSS opportunities		Mobilize
2	Identify potential stakeholders and select sustainability factors		Segment the market	Understand
3	Develop the value proposition	PSS idea generation	Create a value proposition for each segment	
4	Develop the value creation & delivery system and the value capture mechanism	PSS design	Design and implement mechanism to capture value from each segment	Design
	Governance structure – a necessary step but external to our business modelling process	Make the implementation plan	Figure out and implement “isolating mechanisms” to hinder or block imitation by competitors, and disintermediation by customers and suppliers	Implement and manage
<b>Sustainability approach within the business modelling process</b>				
	The three sustainability aspects are considered. It includes a broader vision of stakeholders. Questions in each step provide a guide for sustainability during the whole process.	The three sustainability aspects are considered. It includes a broader vision of stakeholders	Sustainability is only related to economic subsistence and uniqueness of the business model. It is only focused on customer and suppliers.	No specific elements for sustainability are included. It is focused only on economic aspects and considers only customers and business partners.

**Table 6.** Comparison among business modelling processes

## 5.2 Conclusions and future research

Firms are attempting to explore BM innovations in order to address the new challenges of sustainable manufacturing and enhance their current BMs by incorporating economic, environmental and social sustainability in a balanced way. A new business modelling process is required that extends consideration to the broader value network, and frames value in terms of economic, social and environmental, rather than just economic aspects. A preliminary business modelling process has then been developed and refined through discussions with industrial partners. Indeed, the business modelling process presented herein has to be understood as a process that may help firms to integrate sustainability fully into the BM and redefine their business logic in order to maximize the value created and delivered through the business ecosystem, while integrating social and environmental value.

Further research is recommended for identifying and enhancing existing tools or developing new tools for business modelling, which will assist in identifying and integrating environmental and social value perspectives in addition to economic value, and in including a multiple-stakeholder approach. The proposed business modelling process is also envisioned as a model for guiding the collection of tools. Further need is testing the business modelling process and its tools in use cases taken from real industrial contexts.

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