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THE INDUSTRIAL SYMBIOSIS APPROACH: A CLASSIFICATION OF BUSINESS MODELS*

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Abstract

Industrial symbiosis is a collaborative approach concerning physical exchange of materials, energy, and services among different firms: accordingly, wastes produced by a given firm are exploited as inputs by other firms. This approach is able to generate remarkable environmental benefits, since it allows to reduce the amount of wastes disposed of in the landfill and the amount of primary inputs used by the industrial sector.
It has been proved that the economic logic is the basis of symbiotic exchanges. Through industrial symbiosis, firms are interested to achieve competitive advantage coming from lower production costs and revenue increase. Therefore, the first requirement for the establishment of a symbiotic relationship is its economic sustainability for all the firms involved.
In this paper, from the analysis of actual cases of industrial symbiosis, we develop a classification of business models oriented to the symbiotic approach. The classification is based on the different ways in which industrial symbiosis is able to generate economic benefits for the firm that implements it. Six different business models oriented to industrial symbiosis have been identified.
The proposed classification could be useful at the company level, in order to promote the implementation of the symbiotic approach, providing a guide about how to integrate it within its current business models.

Keywords: business models, circular economy, competitive advantage, environmental benefits, industrial symbiosis

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1. Introduction

Industrial symbiosis (IS) is a collaborative approach concerning physical exchange of materials, energy, and services among different firms: accordingly, wastes produced by a given firm are exploited as inputs by other firms (Chertow, 2000).

The IS approach allows to achieve environmental, economic, and social advantages (Mirata, 2004; OEDC, 2012). The environmental benefit is the result of the potential reduction of wastes, emissions, primary inputs, and energy (Chertow, 2000). The economic convenience comes from the savings due to minor costs for wastes disposal and for primary inputs purchase (Albino et al., 2015). Finally, about the social benefits, the IS approach may foster the creation of new firms and new jobs (Mirata, 2004). For these reasons, OECD (2012) considers IS as a "sustainable business model", i.e. a "model that creates competitive advantage through superior customer value and contributes to a sustainable development of the company and society" (Lüdeke-Freund, 2010). In addition, the adoption of IS approach has been explicitly recommended by European Commission, in order to boost resource use and production efficiency (European Commission, 2011).

In order to be successfully implemented, each IS project should be feasible from technical, economical, and legal point of view (Garner and Keoleian, 1995). Literature has largely investigated technical aspects about the implementation of IS projects (Yu et al., 2014) but less attention has been devoted to economic and strategic issues, despite the economical convenience is a precondition for the implementation of IS approach. In fact, the first driver that moves firms towards the IS approach is the possibility to obtain economic benefits from it (Lyons, 2007).

In this regard, in order to foster the adoption of IS approach, it is important to better investigate the different strategies through which companies can create value and obtain economic benefits for themselves by IS.

In this paper, we identify business models oriented to the IS approach and classify them based on the different ways in which they are able to provide value for companies. Our aim is to develop a useful tool for companies to better understand how to integrate IS within their business strategies. The paper is organized as follow: Section 2 describes the methodology used and Section 3 shows the classification of business models. Finally, discussion and conclusions are presented in Section 4 and Section 5, respectively.

2. Methodology

Although many specific classifications do exist for business models, each classification can be widely different in terms of research purpose and business context (Dubosson-Torbay et al., 2002; Lambert, 2015). As we did not find in the literature previous classifications about business models specifically oriented to the IS approach, this paper aims to offer a novel contribution. Accordingly, in order to develop the business model classification, we used an inductive approach (Eisenhardt and Graebner, 2007): we reviewed secondary literature about the implementation of IS projects and we analyzed the business model by which each IS project is driven. Three different sources of case studies have been exploited: i) academic literature; ii) professional literature; iii) companies' websites.

For each case, the source of economic benefits for companies involved has been identified. This information has been used for the development of the classification, in which each model is characterized by different source of economic advantage.

3. The classification

In this Section, the classification of business models oriented to the IS approach is presented. In particular, we have identified six different models: *waste exchange, co-product generation, co-product generation destined to the internal consumption, co-product generation from external wastes, online waste exchange platform, IS-based business oriented to product generation.* Fig. 1 shows a graphical scheme of the proposed classification. In the following paragraphs, each depicted model is presented and supported by a short case example.

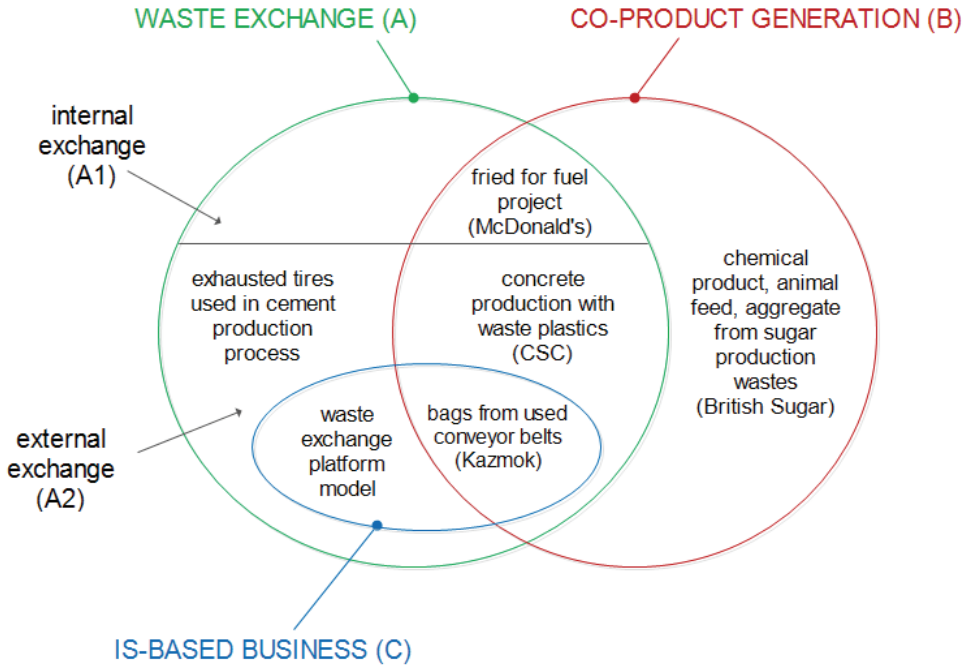

Fig. 1. Graphical classification of business models oriented to the IS approach

3.1. Waste exchange (A)

It is the most common strategy to adopt IS: waste produced by a given production process is used as input by another production process (A in Fig. 1). The involved processes can become to the same firm or conversely can become to different firms: in the first case an internal exchange (A1) is implemented whereas the second one concerns an external exchange (A2). The first sub model is the most simple to implement since it allows to avoid problems arising from inter-firm relationships: non-equal sharing of economic benefits (Fichtner et al., 2005; Paquin and Howard-Grenville, 2009), lack of trust and information sharing (Eilering and Vermeulen, 2004; Gibbs and Deutz, 2007), different bargaining power (Mirata, 2004; Yazan et al., 2012). However, the second sub model has higher potential because the diversity among firms is able to increase the number of symbiotic exchanges technically feasible and then potentially implementable (Korhonen, 2001).

As example of the waste exchange model, we mention a symbiotic exchange involving two companies in the Apulia region (Italy) (Albino and Fraccascia, 2015). Firms belong to different industries: the first firm collects exhausted tires whereas the second one is

a cement producer. Exhausted tires are used as substitute of coal in cement production process. Both firms obtain economic benefits from the symbiotic exchange: the firm collecting tires reduces its waste disposal costs whereas the cement producer avoids sustaining the coal purchase costs.

In addition, in the case of external exchanges, firms can obtain additional economic benefits from fee associated with exchange. In fact, each bilateral waste exchange can be characterized by two different contractual schemes (Albino et al., 2015):

- firm producing waste pays firm receiving waste to dispose it: in addition to lower input purchase costs, firm receiving waste increases its revenues by the transaction fee;
- firm producing waste sells it to the firm receiving waste: in addition to lower waste disposal cost, firm producing waste increases its revenues by the transaction fee.

3.2. Co-product generation (B)

Companies value their wastes in the generation of new products that can be sold on the market. Hence, the company implements a business enlargement strategy since new products are added to the ones currently produced by the company. For this reason, this model is strategically more challenging than the previous one, partially because new products can be much different from products belonging to the company main business.

British Sugar, the largest sugar producer in UK, has adopted this model. It uses wastes from sugar production process, in particular residual resin, pulp, and soil stones, for the production of chemical products, animal feed, and aggregate (Short et al., 2014a). All these products are sold on the market. British Sugar obtains two different economic benefits: lower waste disposal costs and the earnings from the sale of new products.

3.3. Co-product generation destined to the internal consumption (A1∩B)

This model arises from the intersection of the internal waste exchange model (A1) and the co-product generation one (B), as graphically shown in Fig. 1. As in the previous model, companies use their wastes to generate new products: however, in this model, co-products are not destined to the external market but to be exploited within the company.

In 2006, McDonald's launched the "fried for fuel" project, with the goal to produce biodiesel from fried oil generated in its restaurants. The fuel so obtained should have been used to power the company's trucks. The economic advantages of this business initiative are twofold: lower oil disposal costs and lower fuel purchase costs.

3.4. Co-product generation from external wastes (A2∩B)

This model arises from the intersection of the external waste exchange model and the co-product generation one. Companies produce and sell on the market new products exploiting wastes from other companies. As in the co-product generation model, also this one provides the opportunity for business enlargement, since the new products flank the ones already produced by the company. In this case, the production volume is strictly dependent on the amount of wastes received by the firm (Lee, 2011). Therefore, the risk of supply is a critical issue of this model.

As example, CSC s.r.l., an Italian firm producing concrete, has developed a new concrete product made with waste plastics (Short et al., 2014b). Concrete so produced has 50% less weight than the one produced with aggregate. In addition, research has revealed that the use of plastics has positive impacts on lightweight applications, impact resistance, and noise absorption. In the specific case, the company uses plastics from municipal waste collection. The earnings from the sale of new products make up the economic benefits from

the adoption of this model. In order to reduce the supply risk, CSC has implemented a downstream integration strategy creating a joint venture, which directly deals with the collection of plastic wastes.

3.5. IS-based business (C)

The business initiatives belonging to this paragraph are completely based on the IS approach, i.e. the IS approach constitutes the main business of the firms implementing them. Within this category, we can distinguish two different kinds of business, presented in the following sub sections.

3.5.1. Online waste exchange platform [A2∩C-(A2∩C∩B)]

This business model is having a wide dissemination and many new companies are arising to adopt it. Three examples of such platforms are wastetrade.it (Italy), thewastetradecompany.co.za. (South Africa), smileexchange.ie (Ireland). Online waste exchange platforms create an electronic marketplace for wastes allowing the matching between supply and demand. Companies providing such services gain earnings from commissions on transactions.

3.5.2. IS-based business oriented to product generation (A2∩C∩B)

New companies arise with the specific goal to create products from wastes. Kazmok is a Dutch company that produces business bags and accessories made from used conveyor belts, which had a previous life in the flower industry, airports, postal services, in distribution centers, and in the recycling industry. The business of the company is completely based on the IS approach. As for the "co-product generation from external wastes" model, also for this one the risk of supply is a critical issue. In particular, the risk is higher in this case since it can affect the main business of the company. However, in the specific case of Kazmok this risk is very low because the amount of used conveyor belts generated is much higher than the amount required by the firm.

Table 1 summarizes the economic benefits for each identified business model.

Table 1. Economic benefits for each business model.

BUSINESS MODEL	***Lower waste disposal costs***	***Lower input purchase costs***	***Earnings from selling new products***
Waste exchange (A)	X	X	
Co-product generation (B)	X		X
Co-product generation destined to the internal consumption (A1∩B)	X	X	
Co-product generation from external wastes (A2∩B)			X
Online waste exchange platform [A2∩C-(A2∩C∩B)]			X
IS-based business oriented to product generation (A2∩C∩B)			X

4. Discussion

From the analysis, we found that two main models oriented to the IS approach can be implemented: waste exchange and co-product generation. These models are not mutually exclusive since other hybrid models can arise from their combination. IS is not just a strategy oriented to cost reduction but can also be oriented to increase revenues, enter in new markets, and enlarge the corporate business. IS can also be a useful tool able to promote product and

process innovation. Finally, new firms can arise exploiting the IS approach, corroborating the claims in the literature about its high economic and social potentialities (Mirata, 2004).

5. Conclusions

This research identifies different business models based on the IS approach and provides a classification of these models based on the different strategies through which they are able to provide economic benefits for companies. Accordingly, six different business models have been identified from reviewing literature about implemented initiatives of IS.

The proposed classification could be useful at the company level, in order to promote the implementation of the IS approach, then contributing to generate environmental benefits for the collectivity as a whole. It provides a guide for existing firms about how to integrate the IS approach within their current business models, reducing risks of implementation through providing examples from practice. Furthermore, our classification could be used to favor new business initiatives or new firms whose business model is completely based on the IS approach.

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