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Enhancing innovation through behavioral stimulation: The use of behavioral determinants of innovation in the implementation of eco-innovation processes in industrial sectors and companies

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ABSTRACT

The existence of a more sustainable chemical and petrochemical industry has been a long-standing aspiration and demand of modern industrial societies. In this respect, sociotechnical transition processes that hold the principles of green chemistry and green engineering as their main design frameworks represent a promising approach to progress the Brazilian petrochemical sector toward advanced states of sustainability. This raises a number of challenges that are related to the understanding of how such processes could be effected, how sectoral agents' willingness to embrace such trajectories could be stimulated and enhanced and how the main agents, mechanisms and actions, which are integral to the implementation of these processes, could be identified. Drawing on behavioral and innovation theories it was possible to develop a testable and generalizable multilevel conceptual framework that made it possible to learn, document and explain the extent to which companies were willing to engage in such eco-innovation processes and to identify its significant determinants. Thereby, more efficient and effective transition policies could be developed for helping to overcome the dissonance between intention and behavior. The results provided evidence of the central importance of a host of stakeholders and partnerships for developing the conditions and stimuli for the implementation of technical and non-technical changes at the company and sectoral levels.

1. Introduction

It is the general wisdom, within modern industrial societies, that current modes of production and consumption have resulted in unsustainable socioeconomic and environmental consequences (Clark, 2007; Freire da Silva, 2014). Achieving advanced states of environmental, social and economic sustainability has become a strong societal demand and a major challenge faced by the industrial sector in the short through long-term. In the particular case of the relations between societies and the chemical and petrochemical industry, these pressures have been at the center of a long-standing and ongoing debate that was initiated in the late 1960s. New and more advanced systems of production based on new technological paradigms, trajectories and regimes became necessary to reconcile the industry's short-term interest in being profitable with societies' socio-environmental sustainability interests in the long run (Montalvo Corral, 2002).

Changes in this direction are the type of changes that are both wide in scope and deep in complexity as they are conceived and effected based on a large number of agents and dissimilar variables. Such transition processes span various systems and domains and consist of a set of connected changes in technology, the economy, institutions, behavior, culture, ecology and belief systems that reinforce each other (Kemp and Rotmans, 2005). Therefore, corporate and sectoral sociotechnical changes require a good understanding of the nature of the challenges, their significant determinants and are ultimately a function of the perception, beliefs and willingness of the decision-making agents.

This raises a number of challenges that involves, in the one hand, the understanding of the nature of context-specific socio-technical transition processes and the choice of new technical paradigms and trajectories. In the other hand, they are related to

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the stimulation or enhancement of the willingness of sectoral agents to engage in such journey and the identification of the main agents, mechanisms and actions that are integral to the implementation of these transition processes.

This research focused on the Brazilian petrochemical industry. In this context, the principles of Green Chemistry and Green Engineering (GCE) (cf. Anastas and Warner, 1998; Anastas and Zimmerman, 2003) emerged as design frameworks that can realistically conduct the petrochemical sector to advanced states of sustainability. Therefore, implementing GCE as the baseline frameworks for the promotion of socioenvironmental and technical changes toward advanced sustainability states of the Brazilian petrochemical sector[1] implies the engagement of companies in GCE-based eco-innovation processes.

This paper analyzes the contextual conditions for the implementation of GCE-based eco-innovation processes, at the sector and firm level, via the identification of:

- The extent to which Brazilian petrochemical companies were willing to eco-innovate based upon the twelve principles of the green chemistry and the twelve principles of green engineering;
- The significant determinants of companies' behavioral intentionality (willingness) to engage in such pro-environmental behavior and how they can be used in the design of specific policies and strategies for its implementation, and
- The main agents, mechanisms and actions that are integral to the implementation of such transition processes.

Based on behavioral and innovation theories, it was possible to develop and operationalize a theory of planned behavior-based structural, descriptive, innovation-focused, multilevel behavior model to generate qualitative and quantitative information and insights on key factors that can influence the engagement of companies, in the Brazilian petrochemical sector, in GCE-based eco-innovation processes. The research provided a look inside the companies with a focus on the sources of willingness to eco-innovate in GCE by addressing the origins of the problems and not only by focusing upon the symptoms of their inattention.

2. Analyses framework

2.1. A behavioral approach to predict and explain willingness to eco-innovate[2] in sectors

Innovation is a collective and socially constructed process with interactions of interlinked social and economic individual and collective agents (Christ, 2007; Edquist, 2005; Fagerberg, 2005). According to Montalvo-Corral (2002), behavioral aspects associated with the perceptions, beliefs and behaviors of industrial and societal players, regarding socioenvironmental and technical issues, represent key factors that highly influence and trigger eco-innovation processes. Therefore, analyzing the behavioral foundations of eco-innovation should be viewed as a plausible and fundamental way to identifying eco-innovation behavioral determinants thus helping to reverse the "somewhat strange neglect of the behavioral aspects related to the innovation process" (Beckenbach and Daskalakis, 2008). Following the work of Montalvo Corral (*ibid*), this study was conducted at the individual level as a proxy to infer the planned behavior of the firm.

The Theory of Planned Behavior (TPB) is a social psychology-based behavioral theory in which the "true goal of the theory is explaining human behavior, not merely predicting it" (Ajzen, 1991). The TPB was designed to predict and explain behaviors that are not under volitional control and postulates that intention is the immediate predecessor of an action (behavior). In Ajzen's (2005) own words, "intentions are assumed to capture the motivational factors that have an impact on a behavior. They are indications of how hard people are willing to try, or how much of an effort they are planning to exert in order to perform a behavior. These intentions remain behavioral dispositions until, at the appropriate time and opportunity, an attempt is made to translate the intentions into action". According to Ajzen (1991), behavioral intentions are a function of the weighted sum of three constructs:

- Attitude toward the behavior (A): is the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior;
- Subjective norm (SN): reflects both the perceived social pressure to perform a given behavior and the subject's motivation to comply with those pressures and expectations, and
- Perceived behavior control (PBC): is the perceived ease or difficulty of performing the behavior and it is assumed to reflect past experience as well as anticipated impediments and obstacles. The more resources and opportunities individuals believe they possess, and the fewer obstacles or impediments they anticipate, the greater should be their perceived control over the behavior.

A person's overall attitude, subjective norm and perceived behavior control over the behavior are determined by the subjective evaluation of each associated belief and its respective strength. In this realm, a specific behavior is considered explained once its determinants have been traced back to its underlying beliefs (Montalvo Corral, 2002). According to Ajzen (1996) three classes of belief are identified (Fig. 1):

- Behavioral beliefs: are assumed to influence attitudes toward the behavior;
- Normative beliefs: constitute the underlying determinants of subjective norms, and
- Control beliefs: provide the basis for perceptions of behavior control.

2.1.1. Behavior definition

The TPB relies on the internal consistency of beliefs with the constructs, constructs with intentions and intentions with behavior. In this chain of consistency, along the TPB-based descriptive behavioral models, underlie the principle of compatibility formulated by Ajzen and Fishbein (Ajzen and Fishbein, 1977, 2000 and 2005; Fishbein and Ajzen, 1975). According to this principle, attitudes predict behavior only to the extent that the two refer to the same underlying evaluative disposition.

In this regard, the TPB established four criteria for a single behavior definition (Ajzen and Fishbein, 1977):

- The action: a given action is always performed with respect to a given target;
- The target: at which the action is directed;

[1] This research was focused upon measuring and predicting the willingness, of first (basic) and second-generation petrochemical manufacturing companies.

[2] Eco-innovation, at its basic level, differs from "normal innovation" in the sense that it proposes profound changes in: (a) the ways of life, (b) the way products are manufactured, and (c) the logic behind services. The concept of eco-innovation carries the challenge for a radical remodeling of societies' relations with the environment. In contrast, "normal innovations are developed for normal market reasons of reducing costs or for providing better services to users" (MERIT et al., 2007).

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