TECHNOLOGY, INNOVATION AND MANAGEMENT FOR SUSTAINABLE GROWTH: A FLEXIBLE TOOLKIT FOR STRATEGIC TECHNOLOGY MANAGEMENT

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ABSTRACT

Increased environmental and social responsibility awareness, while producing unique opportunities for sustainability-oriented innovations, has generated important challenges for companies. Based on the assumption that new technologies may support more sustainable business, the challenge of really integrating sustainability thinking into business processes is crucial. This paper aims at discussing the importance of sustainable growth thinking in business and strategic foresight as a backdrop to purpose a flexible toolkit for supporting strategic technology management in companies, based on Voros' conceptual model. The toolkit comprises operational modules that can be combined to address a range of R,D&I management challenges. Due to its flexibility and internal consistency, the authors argue that the dissemination of the proposed toolkit can contribute to significant organizational changes related to current corporate practices of strategic technology management.

Key words: strategic technology management; corporate social responsibility; strategic foresight; modular toolkits.

INTRODUCTION

The paradigm of sustainable development presents several challenges to companies that conduct cutting edge research and endeavor to create new, distinctive products and services. It also challenges the markets and society for which new products and services are destined, shaped by cultural value systems and political frameworks.

As the concepts of sustainable development and corporate sustainability were disseminated during the 1990s, this inevitably triggered tensions within organizations, prompting them to reassess their priorities and purposes. This required the adoption of business strategies that meet the needs of the firm and its stakeholders, while protecting and sustaining the resources that will be required in the future. Planning and organizational processes should integrate two of the basic dimensions of business on an extended scale: profitability and legitimacy. Normally applied to government spheres, the latter became perceived by economic agents through the expansion of social and environmental problems, becoming a crucial element in building up sustainable competitive advantages.

Based on the assumption that technological innovations may drive more sustainable businesses, offering companies new options for creating value, the challenge is to discern how the companies

operating in societal and increasingly more complex contexts can include the vision of economic, social and environmental sustainability - equally complex - in their strategic technology management processes.

As an attempt to meet this challenge, this paper aims at discussing the importance of sustainable growth thinking in business as a background to purpose a flexible toolkit for supporting strategic technology management in companies, based on action-research approaches. The toolkit comprises operational modules that can be combined to address a range of R,D&I management challenges. Due to its flexibility and internal consistency, the authors argue that the dissemination of the proposed toolkit can contribute to significant organizational changes related to current corporate practices of strategic technology management.

The main question addressed here concerns the identification of the characteristics and guiding principles of an effective strategic technology management aligned to corporate sustainability thinking. Before purposing a flexible toolkit for supporting strategic technology management in companies, based on action-research approaches, we discuss the importance of sustainable growth thinking in business, advocating that the integration of sustainability thinking into research and development and innovation processes is in best business interests. For designing the toolkit, we establish the following assumptions:

i. new technologies may offer revolutionary solutions that can make obsolete the bases of many of today's industries, making efficient use of raw materials and energy; as well as drastically reducing human 'footprints' on the planet (Hart e Milstein, 1999; 2003);

ii. it is mandatory to develop ways of adapting and making compatible organizational processes and technologies, as well as embrace adaptive planning approaches that treats planning as an on-going learning process (Melo, 1985; 1991);

iii. it is necessary to emphasize the essential role of learning in the process of induced change towards sustainability, as preconized by the transition management literature (Geels, 2004; 2005; 2006; Geels and Schot, 2007; Schot and Geels, 2007; Loorbach and Rotmans, 2006). This is made clear in the new field dealing with 'sustainability transitions' that has gained ground and reached an output of 60-100 academic papers per year;

iv. the configuration of sustainable value creation directly points towards the larger system of which the firm is part, both technically and socially. It makes it clear that activities of the firm are embedded in the larger system (Boons et al., 2013; Schaltegger and Wagner, 2011);

v. in general, changes in established sociotechnical systems are more incremental than radical and such incremental changes are not sufficient to deal with the prevailing sustainability challenges (Melo, 1977; Saviotti, 1996; Raven and Geels, 2010).

To build the foundations for the toolkit here presented, this paper starts conceptualizing corporate social responsibility (CSR) from the business perspective, based on the assumption that emergent technologies and technological innovations may drive more sustainable businesses. Then, a theoretical framework integrating technology management and strategic foresight is presented, in

order to provide the basis for building a flexible and modular toolkit addressed to socially responsible companies. The authors believe that the dissemination of the proposed toolkit, based on Voros' conceptual model, may foster significant organizational changes compared to prevalent technology management practices, still tightly focused on economic benefits of innovations.

THEORETHICAL BACKGROUND

The theoretical background encompasses the following themes: (i) corporate social responsibility (CSR); (ii) strategic foresight (SF), with special attention to the works of Georghiou *et al*., 2008; Keenan and Popper, 2007; Kuosa, 2012; and Miles, 2010; and (iii) strategic technology management supported by SF, as conceived by Voros (2001; 2003; 2005).

Corporate Social Responsibility

The bases for the current concept of corporate social responsibility (CSR) were launched by representatives of the World Business Council for Sustainable Development, in 1998, in Holland. The concept of CSR was associated to the engagement of the stakeholders and to the corporate sustainability in its economic, social and environmental dimensions, as a resultant of sustainable development from the business perspective. Indeed, this concept has been consolidating itself in a systematic and multidimensional way, with a focus on interdependence and interconnectivity between different stakeholders connected directly or indirectly to the enterprise business. As a matter of fact, corporate social responsibility (CSR) has been pointed as a phenomenon that has led enterprises to rethink their role, their obligations, and, even more, the way they manage their businesses. It can be also defined as a holistic, socially responsible and ethical attitude of enterprises in their relationships, namely with shareholders, employees, communities, suppliers, clients, governments and the environment (Carroll, 1999; 2000; Figge *et al*., 2001; Zadek, 1998).

The most general and accepted concept of CSR refers to four categories defined by Carroll (1999; 2000). The Carroll's model includes economic, legal, ethical and voluntary responsibilities. These categories are not mutually exclusive, having on one side economic interests and on the other social interests. The relevance of Carroll's model stems from the basic assumption that social responsibility should not be assessed separately from the economic performance, thus being part of the global responsibility of the enterprise. In this work, we emphasize that enterprises should integrate social and environmental criteria at the normative level of strategic management of their businesses, translating these criteria into objectives and goals, whose results and performance can be measured in a systemic view.

Strategic Forecasting

For building a flexible toolkit for supporting strategic technology management in companies, we considered the main issues to which research efforts have been devoted in strategic foresight, based on recent literature (up to 2013) from future-oriented scholarly journals such as Technological Forecasting and Social Change, Futures, Futuribles, and International Journal of Forecasting, and also from the methodological contents developed by Laboratoire d'Innovation de Prospective Stratégique et d'Organisation (Lipsor), in France. Due to the qualitative nature of the innovation system framework and the methods of analysis that were employed for scenario building and strategic foresight, the research focus was on qualitative results and insights.

A critical assessment of the work done up to 2013 on this theme showed the works of Georghiou *et al.*, 2008; Keenan and Popper, 2007; Kuosa, 2012; and Miles, 2010 as the most relevant for the development of the tool kit in focus.

Technology Management Supported by Strategic Foresight

Strategic technology planning is a field of planning that is shifting from the traditional to more dynamic approaches, which incorporate alternatives and options generated by foresight activities. In particular, Strategic foresight has been recognized as a more explicit and organized form of structuring and facilitating the process of thinking in the planning dimensions (Gavigan and Scapolo, 1999). For purposes of building a modular and flexible toolkit for strategic technology management, the conceptual model developed by Voros (2001; 2003; 2005 was adopted. It is represented in the three diagrams in Figure 1. The aim of Voros' model is to show that the activity of foresight precedes and subsidizes strategic decision making (what needs to be done?) and the formulation of the strategy (what will be done? and how to do it?).
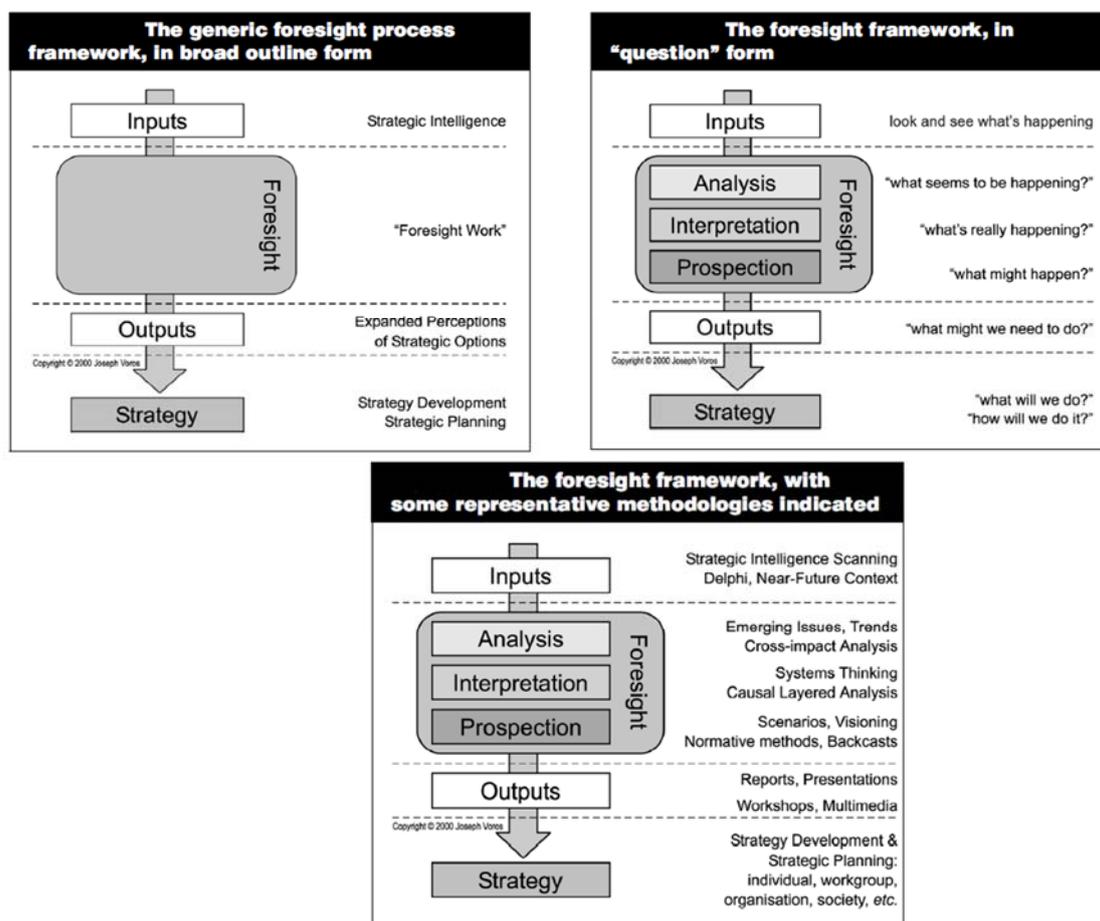

Figure 1: Strategic Technology Management supported by Technological Forecasting: Voros' Conceptual Model, Source: Voros, 2003

Inspired by the work of Horton (1999), the model structure comprises four phases: (i) inputs; (ii) prospection; (iii) outputs; and (iv) formulation of the strategy. The sequential structure proposed by Voros aims to add value to information obtained at the initial stage, transforming them into knowledge and, subsequently, in strategy. The comments on the right side of the schemas shown in

Figure 1 indicate, for each phase, the type of activity to be conducted and the issues of support for such activities.

The goal of the initial phase - titled "inputs" - is to increase the collective perception in relation to topics of strategic interest to the company, seeking to answer the following question: "what's happening?". The aim is to obtain, efficiently, an overview of the macro and institutional contexts concerned with themes and associated topics to be considered. In this phase, it is possible to obtain a consistent image of these contexts and to define the scope of planning activities to be developed in the following stages.

In other words, the "inputs" phase comprises the collection, organization and contents analysis of available information on the subject and its context, in particular studies, diagnostics, analysis and information services of intelligence and high added value. In this phase, are identified the social, technological, economic, environmental, political and legal constraints, that potentially impact the themes and topics in focus. In addition, the stakeholders that should be mobilized throughout the strategic planning process are identified.

In the second phase-"prospection" – the aim is to answer the following questions: (i) "what seems to be happening?"; (ii) "what's really happening?"; and (iii) "what can happen?".

As represented in Figure 1, the results of the previous phase constitute the inputs for the interpretation activities ("what seems to be happening?"); analysis and confirmation of observations ("what's really happening?"); and identification and discussion of alternative futures and movements of actors ("what could happen?").

During the "prospection" phase, the interpretation of trends, signs of change and weak signals, is performed, applying, with flexibility, a set of methods and tools to prospect (Unido, 2005; 2005a; Slaughter, 2001; Porter, 2004). These methods and tools include the construction of scenarios, the Delphi technique, and strategic technology roadmapping. At that stage, the critical factors are: (i) mapping and mobilization of specialists and managers – both internal and external to the organization – around the topics of strategic interest; (ii) the definition of the objectives and scope of the prospection; and (iii) the choice of foresight methods and tools more suitable for each situation.

In the third phase – "outputs", every effort must focus on obtaining and registering of consensus and commitments that occurred along the previous phase. The aim is to refine and consolidate the mapping of the issues involved, especially those of an institutional nature and critical elements for decision making. In this phase, the objective is to get answers to the following question: "what needs to be done?". During the activities of this phase, the process coordinator should seek to extend the collective understanding of the issues arising from previous phases, aiming to intensify the participation of managers and specialists in the activities. For this, workshops with representatives of the multiple stakeholders, for the development of strategic themes, should generate strategic dossiers and roadmap indicating alternatives for future actions.

The main expected result is the transformation of accumulated knowledge in strategies and proposals suitable for decision makers, seeking to expand the perception on strategic options to be incorporated into plans, programs and projects.

Finally, the fourth stage – "strategy formulation" brings together the elements that make it possible to answer the following questions: "what will be done?" and "How should it be done?".

The results generated in this last phase are formally introduced and validated by decision makers. The action alternatives, with different degrees of consensus and commitment, should be discussed and selected for proper prioritization. The expected results include the selection and definition of mechanisms and instruments for implementing the selected options, as well as the identification of topics that require further development and future analysis (emerging technologies, for example).

According to Cuhls and Grupp (2001), this is a process by which one can get a more complete understanding of the forces that shape the future and that should be taken into consideration in the decision-making process related to the strategic management of P&D. The company should include qualitative and quantitative means to monitor signs and indicators of trends in science, technology and innovation and promote the generation of complete solutions in its areas of strategic interest.

A TOOLKIT FOR STRATEGIC TECHNOLOGY MANAGEMENT

The effectiveness of a strategic technological planning process is directly linked to a methodological design set from a delimitation of the questions to be answered, the proposed systematization of the process, the judicious choice of participants and experts involved and the assessment and management of the process that allows to perform adjustments and course corrections with a view to its improvement as a whole.

In this section, a flexible modular toolkit for supporting strategic technology management in companies, based on Voros' conceptual model, is proposed. The toolkit comprises operational modules that can be combined to address a range of R,D&I management challenges (Figure 2).
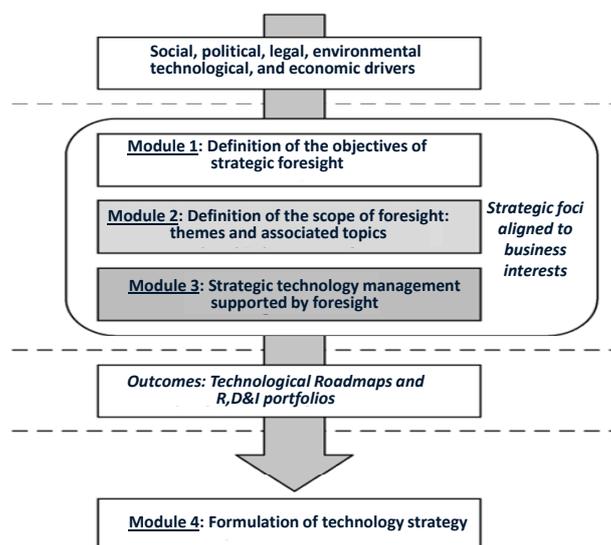

Figure 2: Modular Toolkit for Strategic Technology Management

Due to its flexibility and internal consistency, the authors argue that the dissemination of the proposed toolkit can contribute to significant organizational changes related to current corporate practices of strategic technology management.

Figure 2 schematically represents the tool kit for supporting strategic technological planning process that was conceived in four modules:

- Module 1 – Definition of the objectives of strategic foresight;

- Module 2 – Definition of the scope of strategic foresight;

- Module 3 – Strategic technology management supported by foresight: sustainable business perspective;

- Module 4 – Formulation of technology strategy aligned to sustainable business perspective.

Module 1 – Definition of the Objectives of Strategic Foresight

Technology foresight can be defined as a systematic means of mapping future scientific and technological developments capable to significantly influence an industry, the economy or society as a whole. This module aims to establish, by a participative way, the objectives of the technological forecasting in focus of the strategic technology planning.

Module 2 – Definition of the Scope of Strategic Foresight

Module 2 includes these activities:

- analysis of the external environment, with identification and analysis of the drivers of the future development of the strategic themes in local and global contexts, including the definition of the state of the art and of emerging technologies in these two contexts;

- analysis of the internal environment, focusing skills, physical infrastructure and internal resources, as well as assessing the potential of the company to work in collaborative network (open innovation model);

- strategic analysis of opportunities and threats versus strengths and weaknesses (SWOT matrix), aiming at establishing the foci of the technological strategic planning process;

- definition of themes and associated technological topics, including a brief description;

- formation of Technological Intelligence Networks (TIN) for strategic theme;

- development of Technological Intelligence Reports (TIR) for each strategic theme.

Essential to the success of this module is the institutionalization of TIN (by strategic theme), under the coordination of a technical leader on the issue. This module provides for the reporting of TIR, considered fundamental inputs to Module 3 – ' Technological Foresight'.

Module 3 – Strategic Technology Management supported by Foresight: Sustainable Business Perspective

Module 3, along with the formulation of technology strategy (Module 4), constitutes the heart of the technological strategic planning methodology for the company in its strategic foci (business perspective).

For its execution, several technological foresight techniques can be combined, as the Delphi technique and technological roadmapping and evaluation of the environmental and economic impacts of the technologies that will be developed or adapted.

Fundamental to the success of this Module is the definition of a set of economic, social and environmental criteria for the selection of associated topics, which will be object of strategic roadmapping for the focal themes (Module 4). From this perspective, three complementary activities to the construction of the two technological maps (local and global) were introduced in the methodology. They are:

- the qualitative assessment of economic, social and environmental impacts of technological topics associated with each theme, with prior definition of economic, social and environmental criteria to be adopted for the evaluation;

- elaboration and graphical representation of RD&I strategic portfolios of selected topics, considering the potential, resources and competences of the company, including collaborative networks management;

- systemic consolidation of the RD&I strategic portfolio in the strategic focus (basis for the formulation of the company's technology strategy in this area).

Module 4 – Formulation of Technology Strategy aligned to Sustainable Business Perspective

The chosen instrument for the formulation of the technology strategy aligned to sustainable business perspective is the strategic technology roadmapping (Millett, 2006). The conceptual approach concerning the construction of the company's strategic roadmap for the strategic foci foresees the construction of 'future vision' of themes of interest and the definition of strategic guidelines for the strengthening of the company's strategic positioning on these themes, aiming at achieving the 'future vision' of each theme. Gaps between the ' current situation ' and 'future vision' for the themes are identified, so that strategic initiatives and actions are proposed to effectively fill such gaps.

FINAL REMARKS

Based on the assumption that new technologies may support more sustainable business, this paper discussed the importance of sustainable growth thinking in business and strategic foresight as a backdrop to purpose a flexible toolkit for supporting strategic technology management in companies. Here, we reinforce the importance of strategic foresight for an effective strategic technology management, because alternative futures can be considered, and participants with different background should be actively involved during the execution of four modules of the purposed toolkit.

The toolkit comprised four operational modules that can be combined to address a range of R,D&I management challenges. Due to its flexibility and internal consistency, the authors conclude that the dissemination of the proposed toolkit can contribute to significant organizational changes related to current corporate practices of strategic technology management.

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