Technovation 32 (2012) 216–226

Contents lists available at SciVerse ScienceDirect

Technovation

journal homepage: www.elsevier.com/locate/technovation

Analyzing and organizing nanotechnology development: Application of the institutional analysis development framework to nanotechnology consortia

Minna Allarakhia[a,*], Steven Walsh[b]

[a] University of Waterloo, Department of Management Sciences, 200 University Avenue West, Waterloo, Ont., Canada N2L 3G1
[b] University of New Mexico, The Anderson School of Management, MSC05 3090, University of New Mexico, Albuquerque, NM 87131-0001, USA

ARTICLE INFO

Available online 16 December 2011

Keywords:
Nanotechnology
Consortium
Technology entrepreneurship
Institutional analysis development
Technological convergence
Knowledge management
Intellectual property

ABSTRACT

Governments and companies around the globe have embraced nanotechnology as a strategically critical pan industrial technology. Many view it as one of the essential foundation technology bases of the next Schumpeterian wave. A number of commercial and government sponsored groups have developed a variety of consortia centered on the commercial promise of nanotechnology. Yet the optimal management of these consortia has proven elusive to the point that some suggest that they cannot be managed at all. If these consortia are important, and their effective management crucial, then there is cause for concern. We utilize the case study method to create a nanotechnology consortia management diagnostic model based on institutional analysis development (IAD). Nanotechnology consortia are formed for a variety of purposes and their stakeholders include governments, industries, large firms, SME, entrepreneurial enterprises, and supporting firms.

1. Introduction

Nanotechnology a term first coined by Taniguchi (1974) and suggested as commercially extremely important (Fynman, 1960; Drexler, 1986) is finally being seen by public policy makers and researchers alike as a source (Roco, 2003, 2007; Wonglimpiyara, 2005, Drexler, 2004) of the next Schumpeterian or Kondratieff wave (Schumpeter, 1912; Kondratieff, 1937a,b). Due to the emergent nature and cross industrial use of the technology they are increasingly being commercially embraced through consortia (we use this word to refer to consortia, networks or alliance). Yet knowledge consortia are notoriously difficult to manage using traditional techniques. We seek to add to the answer of this need by developing a variant of the institutional analysis development (IAD) model.

We develop our modified IAD analysis model for the effective management of nanotechnology consortia through our literature review. We first develop three sets of drivers that promote consortia formation. We then present and apply the IAD framework to nanotechnology consortia management.

Our modified IAD framework reveals that knowledge as well as technological and commercialization complexities encourage the development differing consortia forms. Three forms dominate: consortia primarily dedicated to enabling networking between members; consortia driven by the need to bridge together complex equipment for R&D activities; and consortia with the objective of enabling or supporting downstream technology development. Finally, our diagnostic model assists potential stakeholders to decide if their needs align with their embrace of a particular group.

2. A framework for organizing cooperative nanotechnology development

The National Systems of Innovation (NSI) study describes the interactions between the public and private sectors while determining the innovative performance of such organizations (Nelson, 1993). This report includes the import, modification, and diffusion of new technologies; Freeman (1987) suggests that current deficiency band provides the framework within which governments form and implement policies to influence the innovation process (Metcalfe, 1995). Innovation in nanotechnology is often at the interface between nanotechnology and disciplines, the biological, chemical, and physical sciences, are creating knowledge complexities which are encouraging the formation of knowledge-based consortia (Corley et al., 2006; Rampersad et al., 2010). Our modified IAD model directly addresses the management of these consortia.

The IAD is a model that has been used to understand the governance of common pool resources. In order to utilize IAD for nanotechnology consortia management we need to first identify where individuals interact, exchange goods and services, engage in appropriation and provision activities, and solve problems (Ostrom et al., 1994). The activities and the multiple level of rules, and cumulative effect that the action taken obtained are unique in a

* Corresponding author. Tel.: +1 647 988 9843.
E-mail addresses: minna@alum.mit.edu (M. Allarakhia), walsh@mgt.unm.edu (S. Walsh).

0166-4972/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.technovation.2011.11.001

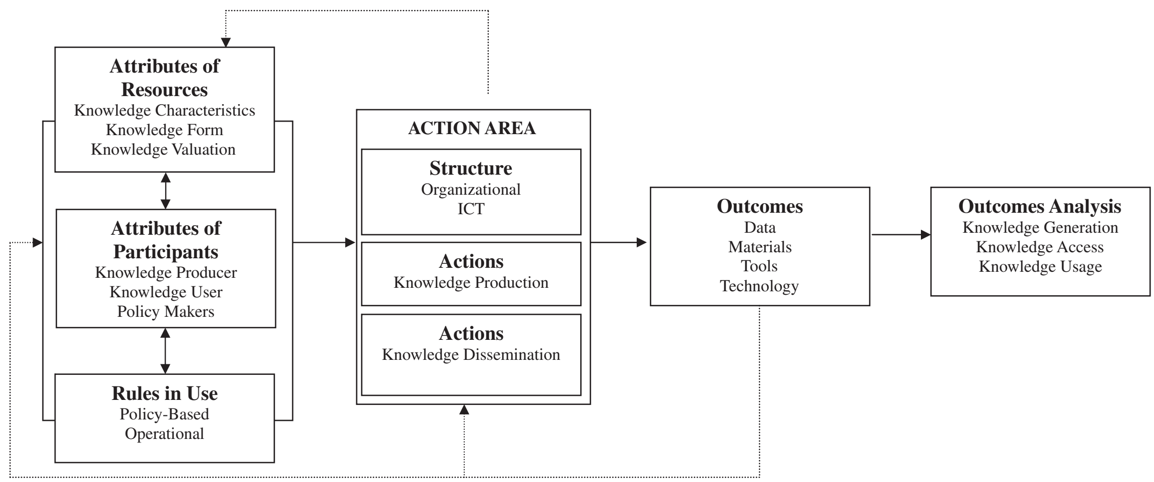

Fig. 1. Modified IAD framework for knowledge-based assets.

given consortium (Kiser and Ostrom, 1982). Fig. 1 illustrates a modified version of the IAD framework for the production of knowledge-based assets such as nanotechnology research in a variety of consortia and stakeholder typologies. We discuss the elements of the model below.

2.1. Consortia and stakeholder objectives

Stakeholders in consortia self-identify their competencies for the purpose of networking. They typically share information concerning scientific developments in the domain; funding and collaboration opportunities; encourage and support new discovery based knowledge generation; and support downstream product development. Consortia stakeholders control technological, knowledge, team member size and nature, commercialization complexities and voids. Interactions are either developed through personnel contacts or an ICT based infrastructure. These objectives are important in the case based on the complex nature of nanotechnology.

The commercial use of nanotechnology creates uniquely valuable solutions (Eijkel et al., 2007), but the required competencies to develop such solutions are often outside the scope of any single firm. Further, nanotechnology based applications are being increasingly applied to a great variety of fields (Mangematin et al., 2003; Allarakhia et al., 2010). Similarly, effective research and application nanotechnology research teams will be formed at the interface of technologies and include biological, chemical, and physical scientists to handle the multi-dimensional aspects (Ideker et al., 2001; Kitano, 2001; Kautt et al., 2007; Boardman, 2008; Boardman and Ponomarioy, 2009). Nanotechnology is not seen as an industry in itself but rather is seen as a pan or cross industrial technology competence (Walsh, 2004). Existing firms regardless of their size understand only a fraction of the industrial setting that the technology base can be applied to. Clearly, nanotechnology as part of a convergent solution often uniquely and dramatically creates value in a current industry setting or creates new ones. This aspect of nanotechnology often creates a need for consortia building since few nanotechnology knowledge generators (Linton et al., 2001) have industry quality competence in other technologies and few existing firms large or small (Kirchhoff and Walsh, 2000; Linton and Walsh, 2004) have a rich history in nanotechnology.

2.2. Attributes of resources

We utilize Hess and Ostrom's (2006) three-fold distinction for knowledge resources in our model to distinguish resources between facilities, artifacts, and ideas. Facilities store artefacts' in order to make them accessible. Artefacts are discreet, observable, nameable representations of ideas, such as articles, research notes, books, databases, maps, computer files, and web pages. Ideas are coherent thoughts, mental images, creative visions, and innovative information. Ideas are the intangible content and the nonphysical flow units contained in artefacts (Hess and Ostrom, 2006). Nanotechnology consortia necessitates a distinction between those resources that are inputs (funding, human capital, tools, equipment) and those that are outputs (information, materials, tools, products) to the consortia. Furthermore, we emphasize the specific character of nanotechnology-based knowledge by considering the form of knowledge (disembodied vs. embodied) as impacting its subsequent management. The knowledge outcomes are then managed physically or licensed to members and/or the public at large. Here, our modified IAD model effectively permits a knowledge-specific level of analysis.

2.3. Actors mapping as participants

Traditional IAD participants are categorized as those that are providers, those that are users, and those that are policy-makers (Hess and Ostrom, 2006). We modify these categories through participant motivation. We cite the motives that Foray (2004) and others identify like the need to manage complex product development issues. Motivation for participation will similarly impact the traditional IAD rules established to govern entry and exit from the consortium ensuring that the objectives regarding knowledge production and deposit levels are achieved and that knowledge appropriation does not occur prematurely (Ostrom et al., 1994). Knowledge flow is distinctly associated with driving motivation for participation in the consortium. Here, our modified IAD model provides an extension to the NSI examined models of knowledge flow by not only considering the mechanisms available, but also the link between participant type, anticipated motivation for participation and the choice and extent of knowledge dissemination (NSI, 2007).

In our model, roles may be assigned including: executive committee member with the responsibility of determining the overall goals of the consortium, seeking commitment from funding partners, and charged with participant selection and entry; scientific advisory committee member charged with the choice, the management and solicitation of projects, etc. while monitoring adherence to the rules prescribed by the consortium including appropriation of knowledge based assets (Ostrom et al., 1994; Munos, 2006).