Research Policy 42 (2013) 613–623

Contents lists available at SciVerse ScienceDirect

Research Policy

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

Niches and networks: Explaining network evolution through niche formation processes

Frans Hermans[a,b,*], Dirk van Apeldoorn[c,1], Marian Stuiver[d,2], Kasper Kok[c,3]

[a] Knowledge, Technology and Innovation, Wageningen University, P.O. Box 8130, 6700 EW Wageningen, The Netherlands
[b] Telos, Brabant Centre for Sustainable Development, Tilburg University, P.O. Box 90153, 5000 LE Tilburg, The Netherlands
[c] Soil Geography and Landscape, Wageningen University, P.O. Box 47, 6700 AA Wageningen, The Netherlands
[d] Alterra, Wageningen University and Research Centre, Wageningen, The Netherlands

ARTICLE INFO

Article history:
Received 18 April 2011
Received in revised form
24 September 2012
Accepted 11 October 2012
Available online 30 November 2012

Keywords:
Strategic Niche Management
Social Network Analysis
Longitudinal networks, Network evolution

ABSTRACT

This paper uses the evolutionary perspective of Strategic Niche Management to investigate and explain the network dynamics of a collaborative innovation network. Building upon the theories of socio-technical transitions, we link macro-level network dynamics to the micro-level niche processes of vision building and experimentation. The paper describes a method to construct longitudinal two-mode affiliation networks and this method is illustrated with an analysis of the network properties of an agricultural niche in the Netherlands over a period of 15 years. Results show how a successful niche grows more connected, even when it grows in size. We found three distinct phases during which the network composition is more or less stable. Powerful actors are able to shape the composition of the network, either through providing the financial resources or through creating "legislative space" for the network to grow.

1. Introduction

The fundamental question of how innovations can contribute to sustainable development is important for both researchers and practitioners. It calls for an understanding of how new technological practices are developed and spread and how these processes can be managed effectively. Sustainable technologies go beyond simple technological fixes, but instead require a reordering of societal structures and social change. The study of these large systemic innovations has been taken up in the relatively new fields of Strategic Niche Management and Transition Management (Kemp et al., 2001; Loorbach and Rotmans, 2006; Rip and Kemp, 1998; Schot and Geels, 2008).

These transition theories hold an evolutionary perspective of technological development that focuses on the socio-technological niche as the place where new technologies emerge (Schot and Geels, 2007). New and divergent technologies are allowed to survive in small protected spaces where the mainstream pressure from the market or other regulatory forces is lower. Historical case studies have shown how many successful innovations started out in a technological niche and how they gradually became more important before they eventually took over the existing dominant socio-technological regime (Geels, 2002, 2006; Geels and Schot, 2007). The lessons from these historical case studies have inspired practitioners to purposefully create and manage socio-technical niches that allow for experimentation in order to further promising novelties.

It is increasingly acknowledged that network structures play an important role in explaining the potential of emerging technologies to spread (Spielman et al., 2010; Van der Valk et al., 2011). An interesting approach to assess a niche is to look at its network. Caniëls and Romijn (2008) were among the first to systematically investigate the network of a niche using Social Network Analysis (SNA) and more recently Lopolito et al. (2011) have used SNA to define several development stages of a niche. This paper aims to take these approaches one step further by studying the characteristics of the network of a niche as it evolves over time. The central questions this paper poses are: (1) how does the network of a socio-technical niche evolve over time and (2) how can these changes in network structure be explained by the internal niche formation processes?

Our analysis of these two questions provides both theoretical and methodological contributions to the study of niches and their roles in socio-technical transitions. The theoretical contribution of this paper lies in its introduction of a perspective of

* Corresponding author at: Knowledge, Technology and Innovation, Wageningen University, P.O. Box 8130, 6700 EW Wageningen, The Netherlands.
Tel.: +31 317 48 4817.
E-mail addresses: Frans.Hermans@wur.nl (F. Hermans), Dirk.vanApeldoorn@wur.nl (D. van Apeldoorn), Marian.Stuiver@wur.nl (M. Stuiver), Kasper.Kok@wur.nl (K. Kok).
[1] Tel.: +31 317 4 87215; fax: +31 317 419000.
[2] Tel.: +31 317 4 81772.
[3] Tel.: +31 317 48 2422; fax: +31 317 419000.

0048-7333/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.respol.2012.10.004

network evolution in the study of niche developments. Studies on the evolution of social networks show how changes in the macro-level network structure can be explained by micro-level processes (Stokman and Doreian, 1997) and in this paper we will review how the niche internal processes of convergence of expectations and learning and testing drives the network structure of the niche.

The methodological contribution of the paper lies in the application of Social Network Analysis on a dynamic network. Descriptions of longitudinal networks are still relatively rare. So rare in fact that Knoben et al. (2006) speak of a "longitudinal gap" that exists in the study of collaborative networks. In this paper we will apply an innovative method that helps in mapping the network characteristics of a network over time in a relatively straightforward manner. We will illustrate this approach by investigating the changes in the network of a Dutch agricultural niche over a period of 15 years. The implications for Strategic Niche Management, the study of transitions in general and the possibilities this approach has for further research are presented in Sections 5 and 6.

2. Niches and networks

A socio-technical niche can be defined as a protected space where promising new technologies are developed. As such a niche forms the micro level of technological and social change where actors are trying out new ideas in a series of dedicated experimental projects (Kemp et al., 1998; Raven et al., 2010). Raven (2005) identified three internal processes that are important for the development of a niche: (1) the articulation and subsequent convergence of visions, (2) learning and experimentation and (3) the building of social networks.

The convergence of actors' visions refers to the degree to which their strategies, expectations, beliefs and practices go in the same direction. A shared vision between collaborating actors is important in order for the different actors to agree on the actions they will undertake (Beers et al., 2010). The actors in a niche are prepared to accept the initial low performance and higher costs of a new technology and are willing to invest their time and resources to improve it. Niche innovations are therefore often carried and developed by small groups of pioneers: dedicated "outsiders" that are marginal to the existing networks of the socio-technical regime and do not share some of the rules with respect to technical development (Van de Poel, 2000). When initial expectations of the innovation are confirmed through positive results of projects and experiments, new actors and organisations are more likely to invest new resources in further developing the technology. This shared expectation provides direction to the projects and experiments done in the niche.

Within a socio-technical niche, learning and experimentation function therefore as a way to test the vision, and to gain experience with a new practice or technology. In many SNM projects there is often a strong focus on social learning and knowledge co-creation. This form of organisational learning takes place in multi-disciplinary collaborative projects that create an opportunity for people to interact, share their ideas and verify their own mental frameworks in discussion with others. During processes of social learning, peoples' perceptions change and they move from typical first loop learning to second loop learning. Their individual mental models are aligned into a shared group model enhancing trust between participants along the way (Argyris and Schön, 1978; Leeuwis and Pyburn, 2002; Pahl-Wostl et al., 2007). Social learning processes thus result in outputs, the practical plans, policies or technical novelties that were produced, and some intangible outcomes: improved relations and trust between actors (Burgess and Chilvers, 2006; Hermans et al., 2011).

Finally there is the composition of the niche and its network. Complex innovations require different partners with different resources and knowledge in order to perform different roles and tasks within the niche (Hermans et al., in press). Research shows that a niche with a limited network in terms of diversity is likely to fail and that niches with broader networks provoke more second-order learning (Schot and Geels, 2008). Other network studies that look at the performance of individuals and corporations as a function of their personal network characteristics show how certain network characteristics can be advantageous for innovative performance, while other are not (Ahuja, 2000; Burt, 2005).

Based on the three niche internal processes of Raven, Lopolito et al. (2011) derived a taxonomy of the potential stages a niche can find itself in, see Table 1. A linear development process is defined in which first a shared vision has to be present, the right actors are to be involved and finally the experimentation and learning can start.

It is clear that the internal niche processes are closely linked to each other and form an iterative cycle of activities in the niche (Loorbach and Rotmans, 2006). Through testing and experimentation the vision will be adapted in a continuous process: promises and practices in a niche develop simultaneously (Stuiver and Wiskerke, 2004). The results of successful experimental projects will make it easier to enrol new actors and expand the network. Negative results, or results that are below the initial expectations, do they opposite: they reduce the faith in the new technology leading to a shrinking network and less resources made available for further testing (Geels and Raven, 2006).

Our first goal is to move from the rather static, linear description of development stages portrayed above to a more dynamic approach that takes into account the changes in the niche network over time. This means that we will look at the network structure of a niche and we will explain the changes in the structural characteristics of the network by referring to the two underlying processes of vision convergence (shared purpose) and learning and experimentation. Following Lopolito et al. we formulate our first proposition:

Proposition 1. Technological niches have different development phases in which the purpose of the actors involved, their learning and experimentation define the network properties of the niche.

According to Head (2008), the character of cooperation within networks change over time with the establishment of trust. In the early stages of the collaborative network, its projects often can be characterised as forms of *cooperation* in which the work is task-focused, generally short term and participants maintain their organisational identities as they strive to obtain the goals and objectives of their own organisation. As trust between participants develops, successful co-operations may lead to more complex and ambitious projects being organised that require more *coordination* among the network participant and the installation of a central coordinating organisation. Joint planning or the implementation of an agreed joint working programme for the medium term can be established. The network stabilizes and a central coordinating organisation is created that can take the form of a special platform or a consortium that coordinates interactions in the network and stimulate its further expansion. Since technological niches are not yet ready to function as a market niche, the coordinating role within these kind of networks is often reserved for the government (Raven, 2005).

Proposition 2. The network structure of a niche becomes increasingly centralised as trust builds up between actors and organisations and they move from cooperation to more coordinated forms of collaboration.

However, there is also a competing force at work. As the network of the niche grows, more and more people will be involved