Expert Systems with Applications 41 (2014) 4579–4595

Contents lists available at ScienceDirect

Expert Systems with Applications

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

Business ecosystem and stakeholders' role transformation: Evidence from Chinese emerging electric vehicle industry

Chao Lu [a,b,*], Ke Rong [c,d], Jianxin You [a], Yongjiang Shi [b]

[a] School of Economics and Management, Tongji University, 200092 Shanghai, China
[b] Institute for Manufacturing, University of Cambridge, CB3 0FS Cambridge, UK
[c] The Business School, Bournemouth University, BH8 8EB Bournemouth, UK
[d] Institute for National Energy Development, North China Electric Power University, 102206 Beijing, China

ARTICLE INFO

Keywords:
Business ecosystem
Stakeholders' role transformation
Chinese electric vehicle industry
Oscillation
Agent-based system

ABSTRACT

Nurturing an emerging industry's business ecosystem always requires stakeholders' efforts and role transformation. By systematically reviewing and studying the evolution of the Chinese electric vehicle industry, this paper constructs a three-dimensional theoretical framework including stages of business ecosystem lifecycle, stakeholder classification and functional roles, to analyse the transformation both of different stakeholders and their functional roles. The findings show that business ecosystem stakeholders have experienced role transformation following a mechanism defined as the 'Triple Oscillation' Model during the evolution of the emerging industry. These findings also help develop a conceptual model of agent-based system for business ecosystem evolution, which could be a starting point for further emerging industry study.

1. Introduction

The emerging industries often arise with the technology and market uncertainty as well as the weak industrial system (Rong, Shi, & Yu, 2013). Thus, in order to cope with such uncertainties of emerging industries, scholars suggested that the business ecosystem around the emerging industry must be nurtured (Moore, 1996), and a friendly and healthy stakeholders network should be set up (Iansiti & Levien, 2004; Kenney & Pon, 2011). The concept of business ecosystem would equip companies with a more comprehensive view of cross-industry collaboration, rather than directly linking partners in the supply chain, as viewed through a traditional lens (Rong, Lin, Shi, & Yu, 2013), which have fully addressed those emerging industries' uncertainties. Thus, the perspective of ecosystem stakeholders could supply us with a proper solution to analyse evolutions of emerging industries, which are very complicated and uncertain. Within the emerging industry's business ecosystem, the stakeholders regarded as agents conducted complex behavior by interacting with other system players (or agents) and the environment (Rammel, Stagl, & Wilfing, 2007). The evolution of the ecosystems was the results of those different stakeholders' (agents) self-decision and interactions (Moore, 1993). The agent is an entity that can be viewed as perceiving its environment through sensors and acting upon its environment (Axtell, Andrews, & Small, 2001). Thus, the agent-based model is an ideal method to understand and govern the behavior of business ecosystems as well as their evolutions (Cao, Feng, & Wan, 2009).

Besides the theoretical perspective, we also found similar evidence and challenges from the practical side of the industry: Chinese electric vehicle industry acting as an emerging industry is under taking the nurturing of its business ecosystem. Though with rapid development in recent years, this industry was still not well established and facing the challenges on how to encourage those stakeholders achieve collaborative innovation and secure a better business model (Kley, Lerch, & Dallinger, 2011; Rong, Hu, Hou, Ma, & Shi, 2013). For example, during the Twelfth Five-Year Plan period, the new-energy vehicle industry, such as that relating to hybrid electric vehicles (HEVs) (Ganji, Kouzani, Khoo, & Shams-Zahraei, 2014) or pure electric vehicles (PEVs) is ranked as one of the seven strategic emerging industries by the Chinese central government. The EV industry is an emerging industry with strong potential for industrialization, which requires support from all stakeholders of the business ecosystem (Rong, Shi, et al., 2013; Rong et al., 2013; Rong, Lin, et al., 2013). The Chinese government has initiated several research and development (R&D) projects and industrialisation explorations through a number of national key scientific research programmes (such as the major "electric vehi-

* Corresponding author at: School of Economics and Management, Tongji University, 200092 Shanghai, China. Mobile: +86 (0) 13621651416.
E-mail addresses: 06luchao@163.com (C. Lu), zryears@gmail.com (K. Rong), yjx2256@vip.sina.com (J. You), ys@eng.cam.ac.uk (Y. Shi).

http://dx.doi.org/10.1016/j.eswa.2014.01.026
0957-4174/

cle" and "energy-saving and new-energy vehicles" projects established by the national "863 program") and large-scale demonstration projects (such as the Beijing Olympic Games, the "Ten Cities, Ten Thousand Vehicles" programme, and the Shanghai World Expo). However, certain issues, such as lack of supporting industrial policy, low R&D capability of the industrial players, not well established technical standards from industrial associations, lack of infrastructure providers, local protection and consumer subsidies, are still bottlenecks that impede the industrialisation of EV. As a result, there is demand concerning research on the electric vehicle industry evolution through the nurturing of its ecosystem. Furthermore, this Chinese electric vehicle (EV) industry is a great example, to explore the emerging industry's business ecosystem evolution and stakeholders' role transformation as well as to understand the interaction of agent roles by employing the agent-based model.

Learning from the issues from both literature and industry, there is still a lack of systematic research on the business ecosystem of emerging industries from the perspective of the transformation of different stakeholder roles or the view of agent-based model. In regard to such research gaps, we further collected data from the Chinese electric vehicle ecosystem from different stakeholders' perspectives and explore how they interact with each other and contribute to the evolution of the emerging electric vehicle industry. The stakeholder theory can serve as an effective starting point for the analysis of Chinese EV business ecosystem. Thereafter, we would be able to grasp the emerging industry's evolutionary trajectory and the dynamic mechanism by drawing a technology roadmap and analysing the business-ecosystem-nurturing process from the stakeholders' perspective. After that, the stakeholders analysis will also provide the basic framework for the agent-based model of a business ecosystem.

This paper is structured as follows: following this introductory section, the second section will review literature on business ecosystem studies, stakeholder theories and the agent-based system; this is followed by a description of the research methodology in the third section. The fourth section will outline the nurturing process of the Chinese EV industry via the method of roadmapping, and this is followed in the fifth section by an analysis of the roles of different stakeholders, with different phases. The sixth section will then construct a conceptual model of agent-based model, and illustrate different stakeholders' (agents) initial status, trigger condition and ending status in a business ecosystem. At last, theoretical and practical contributions of the paper will be concluded, as well as future research directions will be explained.

2. Literature review

2.1. Stakeholder theory and classification

As first proposed by Moore in (1993), the concept of business ecosystem seeks to describe a loosely connected business community composed of different levels of organisations, such as industrial players, associations, governments and other relevant stakeholders, who share a common goal and co-evolve, with the purpose of dealing with uncertain business environments (Moore, 1993). This concept emphasises the importance of stakeholders, which make up the principle subjects of the business ecosystem.

The theory of stakeholder was originated and developed to meet the challenge and innovation of traditional shareholder theory (a view that shareholders or stockholders are the owners of the company, and the firm has a binding fiduciary duty to put their needs first, to increase value for them.), and was mainly adopted to analyse corporate social responsibility (CSR), hostile takeovers, company governance and other issues at the corporate or organisational level. There are two most representative definitions, which focus on broad and narrow levels, respectively, and a great deal of related research has emerged since the 1960s (Clarkson, 1994; Freeman, 1984). Freeman (1984) defined a stakeholder in an organisation as any group or individual who can affect or is affected by the achievement of the organisation's objectives; this definition leaves the notion of "stake" and the field of possible "stakeholders" unambiguously open to include virtually anyone. In contrast, Clarkson (1994) offered a narrower definition of stakeholders as those who bear a level of risk as a result of having invested some form of capital, human or financial, or something of value in a firm, or those who are placed at risk as a result of the firm's activities.

With regard to stakeholder classification, Freeman (1984) suggested that enterprise stakeholders are focused on aspects of ownership, economic dependency and social interests; besides, Frederick and his colleagues divided stakeholders into direct and indirect, using criteria of whether the stakeholders in question have any marketing relations with the enterprise (Frederick, Post, & Davis, 1992); Clarkson also divided stakeholders into active and passive, according to the manner in which they bear the business risk, and into primary and secondary according to the relationship strength between the stakeholder and the firm. Furthermore, based on how many (one, two or three) attributes out of power, legitimacy and urgency are present (Clarkson, 1994, 1995); Mitchell and his colleagues divided stakeholders into definitive, expectant and latent (Mitchell, Agle, & Wood, 1997). Wheeler, meanwhile, introduced a social dimension into the definition of stakeholders, and divided them into primary social stakeholders, secondary social stakeholders, primary non-social stakeholders, and secondary non-social stakeholders (Wheeler, 1998).

However, besides the focus from corporate or organisational level, the current business model and society required more about how to make value out of the interaction with different stakeholders (Im & Cho, 2013). Stakeholders with direct and non-direct business links could contribute to benefiting the business system as a whole, especially in some emerging industries (Kenney & Pon, 2011; Rong, Shi, et al., 2013).

2.2. Structure of the business ecosystem, and role identification

As explained above, different classes of stakeholders can be identified by using different division standards. This gives rise to the following question, which is relevant to the business ecosystem structure and role identification: How do different stakeholders play their roles in the business ecosystem, and what roles do they play?

Moore (1993) proposed that the member organisations within a business ecosystem should include suppliers, lead producers, competitors and other stakeholders; he later expanded this, saying that the economic community involved core business and business environment containing other levels of organisations, such as government, quasi-government, industry associations, standards bodies, competitors, and also business opportunities (Moore, 1996). At the firm level, identified keystone players, niche players, dominators and hub landlords were identified as the four categories of players that participate within the ecosystem (Iansiti & Levien, 2004). These four roles were then further integrated into three roles, with the functions of shaper, adapter and opportunist (den Hartigh & van Asseldonk, 2004). In 2006, Iyer and his colleagues also proposed three types of roles: bridge, hub and broker (Iyer, Lee, & Venkatraman, 2006). In 2011, Rong defined three kinds of functional roles in the business ecosystem from a firm perspective: initiator (who is willing to build the business ecosystem with their platform and product); specialist (who will add value to