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Suitable organization forms for knowledge management to attain sustainable competitive advantage in the renewable energy industry

Amy H.I. Lee [a], Hsing Hung Chen [b,*], Silu Chen [c]

[a] Department of Technology Management, Chung Hua University, Hsinchu 300, Taiwan
[b] School of Business, Macau University of Science and Technology, Taipa, Macau
[c] School of Management, Wuhan University of Technology, Wuhan, Hubei 430070, China

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ABSTRACT

The rapid growth of China's economy has accelerated its energy demand. The exploitation of renewable energy is essential because of limited conventional energy sources, high energy consumption, unstable and escalating oil prices, and detrimental environmental pollutions. Firms in the renewable energy industry are currently facing challenges to maintain competitiveness and productivity while minimizing environmental impacts. The ability to manage knowledge is a key feature in the process for firms to obtain competitive advantages. In addition, interactive learning framework provides a platform that can respond to the need for adjustment in time of great uncertainty. This paper adds evidence to the literature of interactive learning environment based on China context. It examines critical characteristics of interactive learning framework in the renewable energy industry, and then investigates suitable organization forms for knowledge management at different levels of a supply chain. On this basis, this paper proposes suitable organizational forms under different situations for sustainable competitive advantage.

1. Introduction

As one of the largest energy consumption countries in the world, China is facing the challenges of accommodating the ever-growing energy demands and confronting the increasing environment pollutions [1]. Renewable energy development has become a fundamental strategy for tackling the challenges. Due to industrial barriers (such as inadequate technical information, high capital cost, and rigid regulation), the development of renewable energy in China is still in its infancy period compared with developed countries [2]. Especially, the immature technology, management, and methodology in the renewable energy industry need to be improved to confront the aforementioned challenge.

Although some researchers have studied energy efficiency and energy policy in the Chinese renewable energy industry [3–5], relatively little attention has been paid to KM (knowledge management). In addition, among the works that have been done on the knowledge management, only few have examined learning effects through social learning network and intermediaries [6–8]. Actually, in a knowledge-intensive industry, knowledge is a critical factor for obtaining sustainable competitive advantage. Some gaps are still open for further examination, especially in the topic related to the selection of suitable organizational forms in an interactive learning framework. From the perspectives of three different stages of communities, including science and policy decision-making, renewable energy industry and local residents, a platform can promote participants to absorb, share and generate knowledge. Thus, this paper tries to investigate critical characteristics of interactive learning framework in the renewable energy industry and explore suitable organization forms for KM at different levels of a supply chain through empirical analysis.

The remainder of this paper is organized as follows. Section 2 provides a review of interactive learning framework and supply chain of the renewable energy industry. Section 3 establishes hypotheses and illustrates research methodology. Data collection and empirical research are conducted in Section 4. Conclusion is provided in the last section.

2. Literature review

Interactive learning and subsequent innovation have become the driving force to the economic growth in a rapid changing environment. As noted by Peng et al. [9], environment turbulence

* Corresponding author. Tel./fax: +853 62803323.
E-mail address: hhchen2910@yahoo.com (H.H. Chen).

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has a positive direct influence on interactive learning and interactive learning has a positive indirect influence on organization performance. Zhang and Zhang [10] developed a four-factor relation mode including firm knowledge, knowledge-source firm, knowledge-recipient firm, and learning environment. The authors detected that the four primary factors have a synthesized effect on the knowledge transfer process and consequently the learning process in firms' network. Thus, the network provides a platform for inter-organizational learning process. According to Yeunga et al. [11], knowledge-based manufacturers can acquire and exploit knowledge to achieve superior organization performance through creating an interactive learning framework. Recently, Chen and Wang [12] conducted a more sophisticated approach to the lag of interactive learning, finding that exploratory and exploitative learning are positively associated with organization performance while the environmental dynamism negatively moderates the relationship between exploratory/exploitative learning and organization performance.

The improved productivity in China is due to the increasing investment in the downstream supply chain of the renewable energy industry. Even so, knowledge-based manufacturers in China are still on the road to develop competitiveness in the global market by ensuring advanced technologies and resources supply, guaranteeing updated engineering equipment supply, and increasing production efficiency. In order to further study this issue, the supply chain of the renewable energy industry could be divided into downstream, midstream and upstream. Their gaps and possible solutions are described as follows.

2.1. Downstream: improving production efficiency

There is a huge demand in the renewable energy industry. To improve manufacturing cost, time and quality, more sophisticated methodologies with advanced automated technologies are necessary. This is the current weakness in the downstream supply chain of the renewable energy industry. Nevertheless, the gap between China and developed countries is becoming narrower through consecutive internal and mutual learnings. Internal and mutual experiences on advanced equipment, manufacturing technologies, and related knowledge flows, are guided by a mutually learning environment for specific engineering functions. The most suitable form for interactive learning framework shall be the one that has strong knowledge transfer for the specific expertise within the engineering functions.

2.2. Midstream: ensuring local supply of engineering equipment

In the renewable energy industry, advanced equipment and facilities are foundations for mass production. If technologies for solar, wind, biomass, and wave energy are upgraded through a suitable interactive learning platform, mass production can be accomplished in the industry, and in turn, firms can also have extensive R&D infrastructures to improve advanced technology development. Although most firms have good experiences, their technologies are still far behind those in the developed countries. The cooperation with leaders in the renewable energy industry of the midstream supply chain can help ensure local supply of engineering equipment. Furthermore, internal knowledge flows, including human resources and core technologies, can be transferred into external teams, and at the same time, external knowledge can be transferred into the internal teams. Consequently, the most suitable form of interactive learning framework is the one that supports knowledge transfer within internal and external teams, as well as promotes specific knowledge transfer among teams.

2.3. Upstream: securing the supply of advanced technologies

One of the critical factors in maintaining high growth rate is the availability of feedstock [13]. Manufacturers in China are struggling to develop advanced and innovative technologies in the renewable energy industry because science and technology in this level of supply chain are not as sophisticated as those in the developed countries. The cooperation with leading partners in the renewable energy industry is the core principle for most manufacturers since advanced R&D procedures contain a lot of innovative elements which are hard to imitate. Thus, the information flow is small within the internal team, but it can be very high and relatively mutual within the external team. It is apparent that strengthening the interactive learning framework between the internal teams and the external teams becomes significant as knowledge flow from external teams should be learned by internal teams extensively. Finally, the most suitable form of interactive learning framework is the one that can accelerate both the strongest alignment with the strategies of development directions and the rapid spread of common knowledge among teams.

Overall, with the development of science and technology, firms should catch up with the pace of new developing knowledge in attempt to maintain competitive advantages in the markets [14,15]. In fact, knowledge search and knowledge distribution concentrate on the existing knowledge while knowledge creation is the key to technological innovation [16]. Ultimately, suitable organizational forms for KM need to be built to search and distribute existing knowledge, and thereby to stimulate knowledge creation for different processes in a supply chain.

3. Hypotheses and methodology

3.1. Proposed hypotheses

Based on prior research, five organization forms for KM are available, including: (1) sequential KM function: There are four sequential stages including acquiring, sharing, creating, and spreading knowledge stages. (2) central KM function: a CKO (chief knowledge officer) in a team of specialists leads all KM-related activities for projects; (3) project-decentralized KM task force: allocating KM-related activities to the project level and placing a project manager, called "project analyst," in each task; (4) functionally located KM cells: there is no formal organizational unit for KM process, and functional heads of specialized departments take the responsibility of developing knowledge; (5) matrix KM function: automatically and simultaneously importing, absorbing, and exporting advanced knowledge in all procedures without specific KM task force [17–23]. In addition, research has demonstrated that information sources with relative credibility and legitimacy act as the most important roles in linking social network and information perception, risk perception and adaptation [24]. Moreover, salience, credibility, and legitimacy of available information are dominance factors when people make decisions [25]. Scientific community, decision-makers and local practitioners constitute an effective management level which promotes knowledge production and transformation into real practices. Therefore, information and knowledge flows include local information from personal contacts within local resident community, credible information from practical experiences within the renewable energy industry community, and legitimate information from scientific evidences within science and policy decision-making community. As a result, the spillover of knowledge, including absorption, distribution and creation, can be transferred from the policy decision-making community to the renewable energy industry community, and from the renewable energy industry community to the local