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Smart card industry: a technological system

Zouhaïer M'Chirgui*

*GREQAM, Groupement de Recherche en Economie Quantitative d'Aix-Marseille, Université d'Aix-Marseille, II–III
15/19 Allée Claude Forbin, 13627 Aix-en-Provence, France*

Abstract

The aim of this paper is to study smart card industry from a system perspective. This provides three analysis levels. First, it outlines a conceptual approach to the description and analysis of smart card as a complex and diversified technological cluster. Second, it highlights the market structure at three main different levels of downstream/upstream relationship. Third, it deals with the nature of the innovation process. This brings fundamental importance to our analysis. It involves the need for new organisational forms such as networking and system integrators, and co-opetition strategy.

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Keywords: Technological system; Smart card; Market structure; Innovation process; Co-opetition; System integrators

1. Introduction

The smart card¹ industry results from the cross-fertilisation of technologies across several disciplines and resultant broader portfolio of competences. It is articulated around the semiconductors exploitation where an upstream piloting was carried out. Others, specifically know-how, were integrated and took part in product development such as, cards and readers manufacturing, software and hardware development, cryptographic algorithm development, customization, etc. So, the main determinant of the 'smart card' product rests on the combination and the overall coherence of these specific technologies and know-how. Furthermore, the smart card industry is characterized by a strong intensity in the technological change. The technology is becoming more and more sophisticated, particularly in the area of security and operating system/application environment. Admittedly, this change does not create proper substitution to the smart card, but the evolution of the technological solutions have strongly progressed. A better understanding

of the technological changes' evolution supported by an individual and a collective knowledge basis, constitutes a major tool for the development and the creation of the innovation process. This evolution deals with a well organized technological competences developed and described by a technological cluster (GEST, 1986; Zimmermann, 1995) or a technological system (Carlsson et al., 2002). This technological system is characterized by the diversity and the complexity of its technological fields, and by the involvement of several interdependent actors endowed with both complementary and similar competences (Richardson, 1972) and knowledge. The sum of these actors or 'stakeholders' so called by Allen and Barr (1997) and more particularly the smart card manufacturers are in systematic search for collaboration, partnership, etc. in order to integrate knowledge and competences required to the expansion of their activities and on the other hand to reduce the technological, financial and market barriers. Moreover, relations between these actors can draw a mix of competition and cooperation also called co-opetition (Brandenburger and Nalebuff, 1996). The close and dynamic interactions between numerous actors will affect the innovation process, especially relating to the division and the coordination of the innovative activities among them. Consequently, we attend the emergence of new organisational and strategic configurations. It deals mainly with networking and systems integrators.

* Tel.: +33-4-42-96-81-55; fax: +33-4-42-96-80-00.

E-mail address: mchirgui@ehess.vcharite.univ-mrs.fr (Z. M'Chirgui).

¹ The smart card, is an electronic product born two decades ago and constitutes a technology information revolution. It is a credit sized plastic card with a chip embedded in it providing power to serve many different uses. Its industrialization process started during 1980 and since it shows fantastic growth rates.

2. Theoretical foundations

2.1. Technological system

One of the starting points in our work is the notion on system. The use of the system concept varies somewhat in different ways. We identify the technological system (Carlsson and Stankiewicz, 1991; Carlsson and Jacobsson, 1997; Carlsson et al., 2002), the regional system (Saxenian, 1994; Maskell and Malmberg, 1999; Maskell, 2001), the sectoral system (Breschi and Malerba, 1997; Malerba and Orsenigo, 1997; Malerba, 2002) and the innovation system (Freeman, 1988; Lundvall, 1988, 1992; Nelson, 1993; Edquist, 1997; Lundvall et al., 2002).

The approach, on which we will focus in more detail here, is based on the notion of technological systems (Carlsson, 1995; 1997) closely linked to technological clusters (Zimmermann, 1995; Granberg, 1995). Carlsson and Jacobsson (1997) defined technological systems as *network(s) of agents interacting in a specific economic/ industrial area under a particular institutional infrastructure or set of infrastructures and involved in the generation, diffusion, and utilization of technology*. Technological systems are defined in terms of knowledge/competence flows rather than flows of ordinary goods and services (Carlsson and Stankiewicz, 1991). First, system results from the meeting of several industries and disciplines, and the involvement of many interdependent actors endowed with complementary knowledge and competences. Second, it highlights the importance of the innovation process. However, as Carlsson et al. (2002), affirms the technological system can be viewed in several methodological issues. We regard it as an analysis tool of the smart card industry. Through this system, we stress three levels of analysis. First, a level related to the technology which outline the productive process through technological cluster concept (Zimmermann, 1995). Second, a level related to the firms and more precisely to their position throughout the added value chain or the upstream/downstream relation. This level describes the market structure. Lastly, a level related to the process of innovation, through the role of the R&D activities, which improves the performance of the system.

2.2. Competence theories

Secondly, starting from the approach of competences, closely related to technological cluster perspective, we stress the importance of a focusing on the basic craft and more precisely on the 'core competence'. This idea of competence is associated not only with the technological aspect but also with the organisational, commercial, marketing, etc. aspects. Furthermore, The idea of using core competence in a company's strategy formulation has received increasing attention recently. The most widely used definition for a core competence is that of Prahalad and Hamel (1990, p 81). They suggest that *core competencies*

are corporate wide technologies and production skills that empower individual businesses to adapt quickly to changing opportunities. The 'core competence' will be the result of a collection or a combination of distributed competencies in the firm. Therefore, the most successful companies are those which concentrate more on their core competence, but also are those which widen their technological capacities (Gambardella and Torrisi, 1998). The exploitation core competence helps the firm to build its competences around its strategic resources. Strategic resources (Wernerfelt, 1984) are a competitive advantage or disadvantage source for the firm. Yet, the higher the level of competence, the greater the probability that resources can be found to recombine knowledge bases in new and innovative way (Mytelka and Farinelli, 2000). Collaboration and partnership operations become a mainly issue adopted by firms in order to take profit from the complementary elements that company cannot internalise or which cause high costs.

3. Smart card industry: a technological system

3.1. Crafts and competences

Smart card actors are divided into many types, classes and crafts. Usually, we don't find companies holding the integrity of the chain because each class has its specialities. Indeed, an application requires not only the availability of chips and cards but also an extensive infrastructure of readers and terminals, which are part of an overall system and/or network architecture. It is the system design that determines the market success or failure of a given smart card application. Therefore, smart cards manufacturers should have a know-how to encapsulate chip in a card or in a specific case with an antenna (respectively, for the contact and contactless card), and finally to customize and package them. Fig. 1 indicates in a diagrammatic way the chain of actors and crafts present in smart card market.

In reality the majority of the companies exert several crafts, some almost all. These crafts are related to the chips, cards, smart cards, customization, readers and recording devices, software development for smart cards systems and to the interior designers.

3.2. Technological cluster

The smart card industry technological cluster can be represented by the three following levels (Fig. 2). First, the technologies level, and particularly technologies generating new activity forms. These technologies are related to chip, transponder, micromodule, security marks, operating system, masks, cryptography, biometrics, labeling, card, radio frequency, magnetic stripe, etc. Then, the 'core' product(s) level representing its competence. This product is evaluated by its intrinsic performances. We can distinguish products as 'smart card', 'radio-frequency identification (RFID) or

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