Journal of High Technology Management Research xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Journal of High Technology Management Research

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

Participation in technology standards development: A decision model for the information and communications technology (ICT) industry

Ramin Neshati, Tugrul U. Daim*

Portland State University, Portland, USA

ARTICLE INFO

Keywords:
Hierarchical decision making
Analytical hierarchy process
Technology management
Product development
Technology standards

ABSTRACT

This study presents a framework to guide managers in the ICT industry in assessing the factors that inform the decision to participate in the development of technology standards. Using multi-criteria decision analysis and judgment data from panels of experts, a robust model is developed that comprehends the essential criteria and outcomes within the context of computer interconnect technologies. The resultant, generalizable model is validated against the case of the extant Universal Serial Bus (USB) interconnect standard and found to be congruent with the assessment of the experts.

1. Introduction

Innovative technologies produced by the ICT industry permeate all facets of modern human existence spanning education, scientific exploration, commerce, finance, law, medicine, sports, entertainment, social networks, and so on. The products that embody these technologies rest at the core of a vast array of devices and functions such as personal computers, cellular phones, communication networks, game consoles, digital media players, high-performance computers that form the backbone of the Internet, "cloud" services, controllers in modern automobiles and airplanes, mission-critical systems, industrial, medical and life-support equipment, point-of-sale registers and scanners in retail stores, electronic billboards and so on. ICT firms such as Apple, Cisco, Google, HP, IBM, Intel, Microsoft, Oracle, Qualcomm, Samsung and others hold dominant positions in this industry—an industry that has been characterized by some scholars as "winner-take-all" (Schilling, 2002). Ironically, in this dynamic, high-velocity industry no technology firm is "an island, entire of itself." This is especially true of firms whose products depend on technology standards. A standard represents consensus among different agents operating within mutually acceptable practices. Thus, a technology standard can be rendered as an arrangement that enforces conformance of all elements of products, processes, formats, or procedures under its jurisdiction (Narayanan & Chen, 2012).

Technology standardization reduces product incompatibility, increases interoperability, and accelerates broad diffusion and adoption of innovations in the ICT industry. A technology-intensive product such as a smartphone or a personal computer is built with many protected intellectual assets such as patents that are held by any number of ICT firms. While some firms may own impressive portfolios of intellectual assets, no one firm owns all of the patents involved in building a smartphone, a personal computer, or other complex devices. The ideas and methods described by patents find their way into technology standards which are eventually adopted in a variety of products. However, as the complexities of technology markets and the uniform adoption of standards are too daunting for any ICT firm to influence or direct on its own, many firms are faced with IP-related uncertainties

* Corresponding author.
E-mail address: tugrul.u.daim@pdx.edu (T.U. Daim).

http://dx.doi.org/10.1016/j.hitech.2017.04.004

(David & Greenstein, 1990). To develop leading-edge, interoperable products ICT firms enter into standards coalitions to gain access to a broader array of intellectual assets, to interact with ready ecosystems of partners and complementors and to gain a voice in influencing the pace and direction of technology standards development. While beneficial, participation in SDOs can be fraught with risks that are poorly understood and seldom mitigated by these firms. How do ICT firms decide whether or not to join a standards development effort? This and related questions are explored and addressed in this treatise.

A technology standard is developed and maintained by a consortium of representative firms, individuals or legal entities operating within an industry. In the ICT industry, for instance, there are a number of standards organizations with varying levels of openness, authority, influence, charter and function. In this context, openness refers to the degree of availability of participation to an individual, a legal entity, a firm or a governmental agency. Further, the development of technology standards must meet several goals such as the proper form, fit and function of the products built to the standard, the precise definition of compliance to facilitate the interoperability of products, and, most importantly, the lowest possible cost in the development of standards-based products (Reader, 2006). Since technology standards development entails the integration of protected IP, the implementation of the standard may give rise to IP infringement in the absence of a licensing regime. The production of low-cost, standards-based products thus necessitates availability and affordability of licenses to the essential IP required for its implementation.

2. Literature review

The most prominent deliberation in the literature on innovation and technology standardization can be traced to Teece (1986) and his “profiting from innovation” model which boils down to the following question: should technological innovations that are subsumed in standards be licensed and for how much, or should these innovations be given away as open standards to engender broad adoption by the industry, even by competitors? Some scholars such as Kulatilaka and Lin (2004, 2006) have proposed mathematical models to optimize licensing fees for the innovating firm, while other scholars such as Katz and Shapiro (1985a, 1985b), Leibowitz and Margolis (1994) and Shapiro and Varian (1999) believe that network effects alone can accrue sufficient value and utility from the use of standards for both the investing firm as well as the consumer of such goods. Pisano (2006) highlights a major gap in the Teece model whose formulation takes for granted an IPR appropriability regime that is determined exogenously to the firm. Pisano points out that this formulation misses the shift to endogenous regimes where the behavior of the firm can significantly vitiate or bolster its IPR appropriability and the total value of its innovation through complementary assets. Simcoe (2005) echoes Teece when he debates the tension between value creation and value capture inherent in the creation of technology standards (Simcoe, 2005).

David and Greenstein (1990) discuss two distinct themes that reflect the robust debate on the economic issues in the mainstream standards literature. To wit, competition among products that adopt differing standards engenders interoperability and compatibility problems for the consumer, and results in inventory proliferation for the firm. Also, ICT firms are faced with intense pressures to make their product compatible with rival offerings in order to provide choice and variety. The upshot of these trends puts downward pressure on innovation and the spillover effect negatively impacts recoupment of R & D investments. Soh (2010) has shown that ICT firms that exhibit transparent intent and flexibility in adopting and promoting product compatibility stand a better chance of market success (Soh, 2010).

Aside from Gawer and Cusumano (2002), there is little attention paid to firms' incentives to provide resources to advance the work of standards organizations, and even less work has been done to probe the manner in which technologies are selected to be standardized by these organizations. Lemley (2002) and Gibson (2007) point out a major gap in the rules governing IPR disclosure and licensing in a sweeping survey of forty-plus standards organizations. While the heterogeneity in these IPR rules are a recognized gap that have been the topic of studies by other scholars, including the ambiguous definitions for the various licensing regimes, the issue of IP valuation is not adequately addressed.

The literature on the impact of standards development on product and process innovation builds on the groundbreaking work of Utterback and Abernathy (1975), in which they recorded patterns of innovation within technology firms and developed various models to explain the rate of innovation of products and processes on the basis of the firm's chosen business and competitive strategy (Utterback & Abernathy, 1975). One of the main upshots of this research suggests that technology firms race to propagate their own implementation of a technological innovation in order to establish de facto standards which others will have to emulate. In applying the Utterback and Abernathy model to the firm's strategic alliances, Mauri and McMillan (1999) find that technology-intensive firms form alliances as the level of technology complexity and cross-dependencies increase (Mauri & McMillan, 1999). Their findings buttress the Uterback and Abernathy product and process innovation models and contradict a large body of research which contends that technology firms avoid alliances to protect their intellectual assets from exploitative and opportunistic behaviors of their rivals, partners and others in their ecosystem.

2.1. Multiple perspectives

A substantial portion of the academic literature on standards development and its association to technological innovation in the ICT industry is organized along various perspectives such as Economic, Strategic, Organizational, and Legal (ESOL). These perspectives indicate the primary emphases and foci of the scholars.

2.1.1. Economic

Farrell and Saloner form a duo of economists with prolific contributions to the standards literature. In a seminal study, Farrell and