



Theoretical Justification for IT Infrastructure Investments

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The strategic importance of building highly capable information technology (IT) infrastructure has become a crucial management issue of the 1990s and beyond. However, in spite of the numerous benefits attributed to IT infrastructure, these claims remain unsubstantiated. This problem is due, in part, to inadequate conceptualizations of IT infrastructure and its measurement as well as a lack of theoretical frameworks for explaining its impacts. To address these problems, this paper proposes a theoretical framework to justify the value creating potential of IT infrastructure investments. First, we provide a conceptual framework that describes the nature of IT infrastructure and its related components. Next, we discuss the role of IT infrastructure as a competitive weapon and identify three areas where it may create strategic value for the firm: responsiveness, innovativeness, and economies of scope. For each area, specific theories are used and research propositions are developed to guide future infrastructure research.

The need for building a responsive information technology (IT) infrastructure has emerged as a critical IT management issue of the 1990s and beyond (Broadbent, Weill, O'Brian; Neo, 1996; Broadbent & Weill, 1997; Weill & Broadbent, 1998; Keen, 1991; Koch, 1997; Niederman, Brancheau, & Wetherbe, 1991; Sambamurthy & Zmud, 1992; Venkatraman, 1991).

"An information technology infrastructure is vitally important to companies, particularly those in industries going through dynamic change, those re-engineering their business processes, and those with widely dispersed operations" (Broadbent & Weill, 1997, p 77).

For many companies, IT infrastructure investments are long-term commitments that account for more than 50% of the IT budget and about 4% of revenues (Broadbent & Weill, 1997). Consequently, many argue that major infrastructure decisions warrant the attention of senior management (Broadbent & Weill, 1997; Davenport & Linder, 1994; Duncan, 1995; Koch, 1997; Koeller, 1994; Sambamurthy & Zmud, 1992).

"Infrastructure is becoming too important to the company's survival to leave the decisions up to the IS department alone. CIOs can no longer afford to say, 'Trust me, I'm managing the infrastructure.' The numbers have

simply gotten too big." (Koch, 1997, p. 6).

IT infrastructure has become vitally important as managers seek to insure standardization, compatibility, and inter-operability among potentially diverse organizational information systems. Furthermore, the seemingly endless variety of hardware, operating systems, and application development tools have placed an added burden on IS managers to maintain a consistent IT architecture to avoid fragmented systems, lack of integration, or, as Lindquist (1992) refers to, "islands of automation." Consequently, the development of corporate IT infrastructure has become an urgent activity for many organizations to insure some degree of cohesiveness among the firm's diverse computers, operating systems, networks, core databases, and mission-critical applications (Niederman et al., 1991). Notwithstanding this, a heightened awareness by senior management of the competitive potential of IT infrastructure has contributed to its importance as a critical IT issue (Barney, 1986; Keen, 1991; Niederman et al., 1991).

While numerous articles cite the value-creating potential of IT infrastructure (Campanelli, 1993; Cox, 1993; Rockart, 1988; Vincent, 1993), much of the evidence for infrastructure benefit lies in the realm of conjecture and anecdote (Duncan, 1995). Consequently, a clear theoretical framework for assessing the value-creating capabilities of IT infrastructure is lacking. To address

this issue, we have undertaken to articulate how IT infrastructure creates value and then to provide theoretical arguments for substantiating these claims. Answers to such issues are critical to senior managers who face the daunting task of justifying infrastructure expenditures (CSC Index, 1993; Duncan, 1995; Markus & Soh, 1993; Parker & Benson, 1988). First, we provide a conceptual framework that describes the nature of IT infrastructure as a shared corporate resource composed of physical assets, intellectual assets, and IT standards. Next, we discuss the role of IT infrastructure as a competitive weapon and identify three areas where it may create strategic value for the firm. For each area, specific theories are elucidated to provide a theoretical basis for substantiating each of these IT infrastructure capabilities. Subsequent research propositions are offered to guide future infrastructure research. The paper concludes with a discussion of limitations, research challenges and potential strategies to overcome them.

CONCEPTUAL FRAMEWORK OF IT INFRASTRUCTURE

The common theme that emerges from the evolving conceptualization of IT infrastructure is that it is an organizational resource typically coordinated by some form of central IS organization and shared across organizational units (Davenport & Linder, 1994; Duncan, 1995; Earl, 1989; Henderson, 1990; McKay & Brockway, 1989; Niederman, Brancheau, & Wetherbe, 1991; Rockart, 1988; Weill, 1993). For example, a telecommunications network coordinated by the corporate IS department and shared by multiple business units would constitute a shared organizational IT capability.

From this perspective, IT infrastructure can be viewed as a shared resource that consists of both physical and intellectual IT assets (Broadbent et al., 1996; McKay & Brockway, 1989; Sambamurthy & Zmud, 1992; Venkatraman, 1991; Weill, 1993). Whereas the physical component of infrastructure refers to actual IT artifacts (e.g., client server networks, data, e-mail), the intellectual component includes the specific body of IT-related knowledge, skill sets, and experience. These intellectual assets act as the "mortar" that binds the physical IT components into robust and functional IT services (McKay & Brockway, 1989). Like the physical view, the intellectual view by itself forms an incomplete picture of infrastructure. A firm may have the necessary knowledge, skill sets, and experience with IT; however, the IT infrastructure is incomplete in the absence of the physical IT assets to which this expertise can be applied. Weill (1993) provides a clear definition that conceptualizes IT infrastructure both in terms of intellectual skill sets as well as specific physical IT resources. He defines IT infrastructure as:

"The base foundation of IT capability budgeted for and provided by the information systems function and shared across multiple business units or functional areas. The IT capability includes both the technical and managerial expertise required to provide reliable services." (Weill,

1993, p. 553).

While firms may possess the requisite IT assets (physical and intellectual) for a reliable infrastructure, corporate IT standards and policies governing the use of these assets may enhance the firm's ability to capitalize on these assets' deployment. A standard can be defined as a definitive rule, principle, or guideline established for the purpose of instituting uniformity in organizational behaviors and practices. Related to the IT context, infrastructure standards are defined as guidelines that dictate how IT assets are to be acquired, managed, and utilized within the organization. Thus, it is conceivable that a given firm may have a well-developed IT asset base (in terms of physical and intellectual IT assets); however, a lack of standards on how to utilize these assets may result in an inability to integrate the systems across the organization. Consequently, organizational routines or standards may need to be established to insure that human expertise is applied to IT assets in meaningful ways (Darnton & Giacometti, 1992; Turnbull, 1991). Weill (1993) highlights the importance of IT standards:

"The provision of a reliable IT infrastructure implies an architectural responsibility. Sufficient standardization of computing is required to ensure that business units and functional areas can take advantage of the infrastructure. Therefore, a firm-wide architecture [set of standards] is an integral part of providing an IT infrastructure." (p. 555).

The use of data definition standards provides a useful illustration of these concepts. A firm may have the physical assets (the database) as well as the human expertise required to use these assets; however, standards provide the mechanisms that guide how these two assets interact. Data definition standards dictate a set of uniform rules so that the overall organization can benefit from a consistent set of meanings and names for the commonly used data. Failure to provide these standards may result in data redundancy, confusion over data names, and an inability to integrate the common data definitions across the whole organization.

Thus, while prior conceptualizations have primarily defined IT infrastructure in terms of physical and intellectual assets, we argue that technology standards form a critical third component of IT infrastructure. We distinguish standards from intellectual assets from the standpoint that standards normally become routinized as part of the organizational memory (Huber, 1991; Walsh & Ungson, 1991) whereas intellectual assets may be more transient and less routinized. As Table 1 illustrates, IT infrastructure can be conceptualized as a shared corporate resource that consists of physical and intellectual components "held together" by organizational standards regarding their use.

Figure 1 presents a framework that builds upon the notion of IT infrastructure that extends beyond the concept of a purely physical infrastructure to one that contains physical assets, intellectual assets, and IT standards. Shared IT ser-

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