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THE ADOPTION AND USE OF NATIONAL INFORMATION INFRASTRUCTURE: A SOCIAL NETWORK AND STAKEHOLDER PERSPECTIVE

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Abstract

This study draws upon stakeholder theory and social network analysis to examine the diffusion of national information infrastructure (NII) among two key stakeholders—the end users (or customers) and application/service providers. The context chosen is Singapore ONE. The study also investigates the types of mechanisms utilized by network participants for resolving their concerns with respect to NII adoption.

1. INTRODUCTION

The emergence of Internet technology coupled with rapid advancements in telecommunications have created a plethora of opportunities for organizations as well as individual users to communicate and share information. Recognizing the profound impact and promise of this new technological paradigm, several national governments have initiated programs to develop their own national information infrastructure (NII). Most NII projects have typically involved three major activities: (1) formulating a vision—such as the "Intelligent Island" vision of the Singapore government, (2) marshaling appropriate policies or policy frameworks, e.g., on intellectual property rights, and network access mechanisms, and (3) formulating specific implementation strategies. Indeed, NII has been defined as an "inchoate, multidimensional phenomenon, a turbulent and controversial mix of public policy, corporate strategies, hardware and software that shapes the way consumers and citizens use information and communications" (Wilson 1997, p. 4).

Being a relatively new phenomenon, there is a paucity of studies examining the challenges and outcomes of NII projects. Given the widespread impact that is anticipated from NII projects, a number of other issues and questions beg to be addressed. One critical issue, of potential interest to all NII stakeholders, is the adoption and usage of the NII by two key participants—the end-users (or customers) and the application/service providers. We draw upon stakeholder theory and social network analysis to examine the diffusion of the NII among these stakeholders. Consistent with social network analysis, we argue that the nature of ties developed by a particular stakeholder with other significant stakeholders determines the extent to which the focal stakeholder will adopt and use the NII. A second critical issue relates to the types of mechanisms utilized by network participants for resolving their concerns with respect to the NII. Thus, we further examine how the existence and quality of network ties facilitates the resolution of concerns related to adoption and diffusion. The study context is Singapore ONE (S-ONE), the NII project in Singapore, which has been one of the early starters in the NII race.

2. THEORETICAL BACKGROUND

NII projects are characterized by the participation of a wide range of private and public sector entities with varied interests and expectations (OECD 1995; Wilson 1997). It is evident then that the success of NII projects needs to be examined at the confluence of interests of these varied stakeholders, and as such, stakeholder theory (Freeman 1984; Brenner and Cochran 1991) is an appropriate theoretical base for the study of NII projects. Since Freeman published his seminal piece, *Strategic Management: A Stakeholder Approach* (1984), a number of researchers have utilized this approach to analyze organizational responses to various external and internal influences. Recent work in this area (Brenner 1993; Mitchell, Angle, and Wood 1997) has contributed greater theoretical rigor to the stakeholder approach and established linkages with alternate organizational theories such as agency theory, resource dependence theory, and transaction cost theory.

Rowley (1997) tied stakeholder theory to social network analysis. He argued that firms "do not simply respond to each stakeholder individually; they respond rather to the interaction of multiple influences from the entire stakeholder set" (p. 890). In other words, rather than focusing on dyadic relationships, we need to examine the *simultaneous* demands of multiple stakeholders. Such simultaneous analysis is made possible through the application of social network theory, which examines relational systems in which actors dwell, and helps determine how the nature of *relationship* structures (network ties) impact the behaviors of network participants. It is this theory that we apply to specify the antecedents of the adoption and usage behaviors of stakeholders.

3. SINGAPORE ONE: THE NII FOR AN "INTELLIGENT ISLAND"

Singapore ONE is a major initiative by the Singapore Government to create a national broadband network that can deliver interactive multimedia applications and services to every home, business, and school in the country. S-ONE's heritage lies in the IT2000 masterplan. Launched in 1992 by the National Computer Board (NCB), IT2000 provides a framework to guide information technology (IT) development in Singapore and the transformation of the country into an "Intelligent Island" where IT is pervasive in every aspect of the society. At the heart of IT2000 plan is a "3C" view of IT: computation, conduit, and content. To transform the vision into reality, the IT2000 plan proposed two major paradigm shifts: the need to develop an integrated and advanced NII, and the need to promote content digitalization and the development of multimedia content industries. Singapore ONE is an important step in this direction. Launched in June 1997 with approximately 50 applications and services, it is expected to cover the entire city by the end of 1998. At present, more than 100 diverse applications and services are offered by approximately 70 application providers. Users (both individual as well as businesses) need to subscribe to S-ONE in order to access the applications and services available. A preliminary stakeholder network for S-ONE, shown in Figure 1, will be further developed and validated during the course of this study.

A central tenet in social network analysis is that network characteristics such as density, centrality, and power influence patterns of interaction among and the behaviors of network participants. Prior research has related network characteristics to a wide variety of outcomes including constraints on unethical behavior (Brass, Butterfield, and Skaggs 1998), the adoption patterns of a new technology (Burkhardt and Brass 1990), and patterns of media usage (Contractor and Eisenberg 1990). We focus on one key characteristic of the stakeholder network: an actor's centrality within the network (Brass and Burkhardt 1993; Oliver 1991; Rowley 1997).

Centrality has been defined in prior work in a variety of ways (Scott 1991). For example, distinctions have been drawn between "local centrality," which assesses the extent to which an actor in the social network has a large number of ties with other actors in an immediate neighborhood, and "global centrality," which is indicative of prominence within the whole network. More generally, the concept of centrality relates to the power and prominence obtained by an actor through the network structure as opposed to power gained through idiosyncratic individual attributes (Rowley 1997). Recent conceptualizations of centrality refine the construct to include two aspects of prominence: (1) closeness centrality, a global measure, which defines an actor's ability to independently access all other members of the network (Freeman 1979), and (2) degree centrality, a local measure, which examines the number of network participants directly connected to the focal actor.
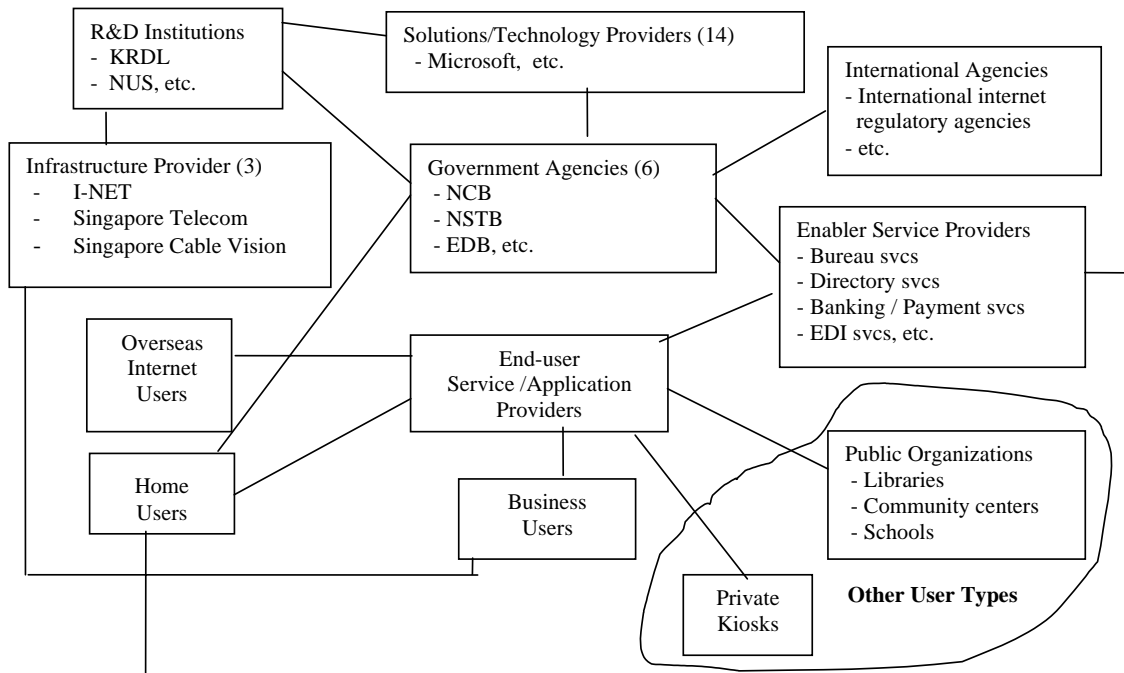
Figure 1. Singapore S-ONE Stakeholder Network

Figures 2(a) and 2(b) present our research models. The fundamental premise underlying both models is that the centrality of an actor in the network influences adoption behavior via mediating influences. For the purposes of deriving our hypotheses, we differentiate between two parts of the S-ONE network: the supply-side network, which consists of application providers, government regulatory agencies, and technology/infrastructure providers, and the demand side network, which consists of business and non-business users, and affiliated user communities (associations). In the demand side network, consistent with a rich literature examining the perceived characteristics of innovations that are positively related to adoption behavior (e.g., Rogers 1994; Tornatzky and Klein 1982), we also include complexity, relative advantage, and compatibility as potential direct predictors of adoption.

End users' high degree centrality in the demand side network—having many direct relations with other users—implies alternative sources of information and resources for resolving potential problems, which contributes to a more positive atmosphere for adoption and usage of the NII (Rowley 1997). Alternatively, high degree centrality could influence adoption behavior via a bandwagon effect (Abrahamson and Rosenkopf 1997) by exerting social pressure. Indeed, low degree centrality implies longer lead times for resolving specific issues and an overall sense of lack of control that would translate to a more conservative attitude toward adoption. For application and service providers, both degree and closeness centrality in the supply-side network are primarily associated with more efficient exchange of information with other service/technology providers and network regulators. By reducing technological uncertainty and amplifying perceived ability to resolve operational issues, centrality is hypothesized to enhance propensity to offer a greater number of products and services over the network.

Our second research objective is to identify key barriers related to the adoption of NII by the two stakeholders, and how these barriers might be overcome through the use of network mechanisms or relational ties. Some of the issues widely discussed in the trade literature include, at the user level, ease of use, trust, privacy, and access related concerns, and, at the provider level, security, intellectual property rights, interoperability, and scalability. We have developed a conceptual taxonomy for categorizing key barriers into people issues, information issues, technical (software, hardware, and network) issues, and resource issues. We will examine the barriers to adoption by considering their perceived importance, the network ties that affect them, and network mechanisms for resolving them.
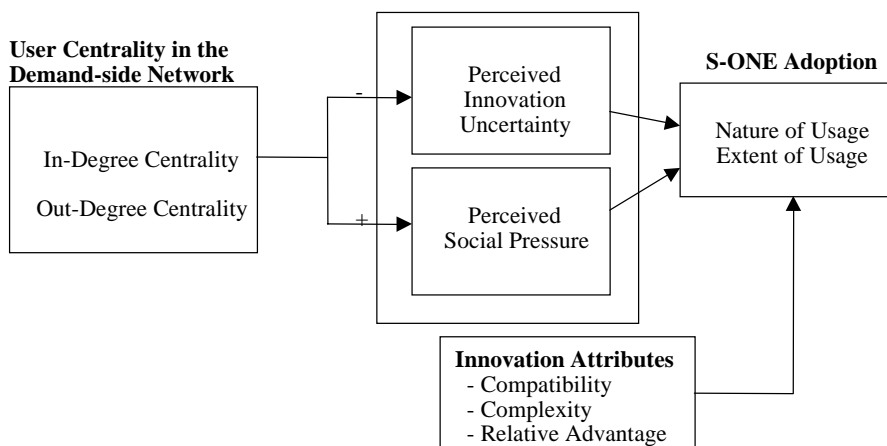
Figure 2(a)

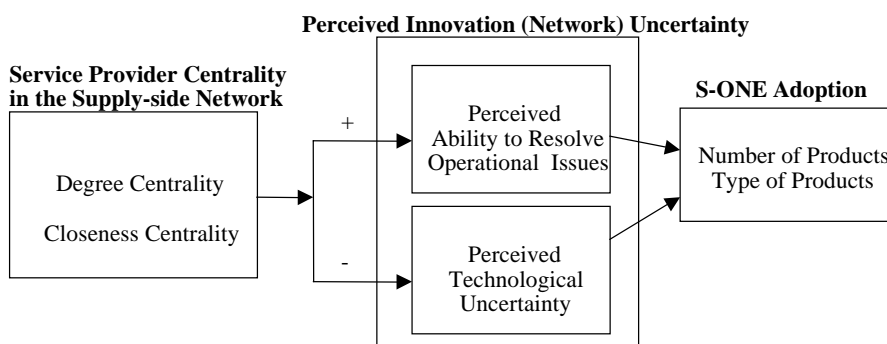**Research Model: S-ONE Adoption by End Users**

Figure 2(b)

Research Model: S-ONE Adoption by Application/Service Providers

Figure 2. Research Model

4. RESEARCH METHODOLOGY

The study will be conducted in multiple phases and will use a mix of quantitative and qualitative techniques to collect and analyze the data. In the first phase, we develop the preliminary stakeholder network for S-ONE using the snowball technique for delineating network boundaries and collecting relational data (Scott 1991; Wasserman and Faust 1994). Next, interviews with a sample set of end-users and service providers will provide insights into the set of issues affecting their adoption of the NII. A third phase entails a cross-sectional survey of a larger set of users and providers. Respondents will provide information on the perceived importance of the various adoption issues (from a preconstructed list) and their usage characteristics. Home users' degree centrality will be measured by asking them to specify the number of other users they interact with on a regular basis to resolve/discuss NII usage related matters. Service providers will be requested to indicate, based on a previously prepared list, those supply-side stakeholders with whom they maintain direct ties. Degree and closeness centrality will be measured from this data using existing methods (Ibarra 1993; Brass and Burkhadt 1993). Hypothesized mediating variables will be operationalized using measurement scales developed in prior work. Both sets of respondents will also be asked to provide a subjective rating

of the quality of the ties they maintain with the different network actors. Data analysis will focus on relating centrality constructs with adoption data.

In the final phase of the study, based on the data that have been collected, we will conduct focused interviews with a representative sample of all key stakeholders. These interviews will examine various mechanisms the nodal agency and other constituents have deployed to build and maintain network ties and the nature of the issues such mechanisms resolve.

5. EXPECTED CONTRIBUTIONS

As one of the first studies examining the adoption of NII projects, we believe that a primary contribution of this study will be in identifying the key managerial issues and barriers related to NII adoption by end-users and service providers. An important implication, then, will be in terms of the design of appropriate mechanisms by the nodal agency to resolve various issues. A second contribution of the study will be to provide additional insight into the relationship between network centrality and adoption. The network theory of stakeholder influences (Rowley 1997) is relatively new and to our knowledge has not been empirically examined in any context. This study should provide a fertile ground for testing the robustness of the theory and offering potential extensions. Finally, Singapore presents a unique context to understand NII management issues. It has been a leader in deploying the newest information and telecommunications technologies. On the other hand, as a tiny city-state, Singapore provides a microcosmic perspective of NII implementation. As such, the Singapore experience can provide important lessons for NII initiatives in other countries.

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