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Information infrastructure, governance, and socio-economic development in developing countries

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Abstract
There is growing interest in the role and contribution of national information infrastructure (NII) to the quality of governance and the socio-economic development of nation states. In this paper, we use publicly available archival data to explore the relationships among NII, governance, and socio-economic development in developing countries. Results substantiate a significant relationship between NII and governance, and NII and socio-economic development. The findings suggest that NII have the capacity to contribute to country development, both directly (via impacts on socio-economic development) and indirectly (via its impacts on governance, which in turn influences socio-economic development).
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Introduction

While a great deal of research has been conducted in recent years on how nations create information infrastructures, the influence of such infrastructures on country governance and socio-economic development remains – except for a few recent studies – at best anecdotal and conjectural (Meso *et al*., 2006). The key question is: can such infrastructures demonstrate tangible benefits to those who deploy them in the national arena? Emerging research provides contradicting responses. One group of research points to the positive impact of select groups of information infrastructures on socio-economic development and/or governance. Examples include Dutta (2001), Gatica (1994), Mbarika *et al*. (2001, 2002a, 2005), Meso & Duncan (2000), Nidumolu & Goodman (1993), Nidumolu *et al*. (1996), Organization for Economic Co-operation and Development (OECD) (1997), Rose & Straub (1998), Sheffield & Gallupe (1995, 1996), Straub & Watson (2001), Straub (1994), and Meso *et al*. (2006), among others. However, others argue that governance and socio-economic development are complex phenomena which cannot be direclty improved by the effects of technology alone (Walsham & Sahay, 1999; Casely, 2004; Avgerou *et al*., 2005). Still, there are those who indicate that technology's impact on governance and socio-economic development is heavily dependent on the context and environment in which the technology is implemented. A good example is Ciborra & Navarra (2005) who show that implementing information infrastructure solutions aimed at improving governance is not an easy task, is fraught with a number of

risks, and may not necessarily be conducive to enhancing country development. We also observe that most of the investigations into the influence of information infrastructure on governance and socio-economic development have been undertaken via a qualitative, usually case-study, approach. In this paper, we seek to identify if indeed there is quantitative merit in the relationships among information inftrastructure, the quality of country governance, and the levels of socio-economic development when the entire collection of developing countries is examined as a block. While the insights we obtain do not replace the deep insights obtained from a qualitative assessment of the impacts of information infrastructure implementations within the narrow confines of a single case-study or a handfull of comparative case studies, we feel that they illuminate our understanding of the contributions of national information infrastructure (NII) at the national level by providing a macro-perspective of its impacts on key national-level development parameters.

Using archival data, the current research analyzes the relationship between NII and governance quality in 144 developing countries. The rest of the paper is organized as follows: in the ensuing section we present the research model and hypotheses. This is followed by the section on research design. The section after that presents the analysis and results of the study. We then discuss the results and the implications for future research. The final section provides concluding remarks with a restatement of the value of the work.

Research model and hypotheses

There is evidence that NII solutions, when effectively implemented, facilitate and support good governance. For example, Sheffield & Gallupe (1995, 1996) report on the positive contributions of electronic-meeting infrastructure on policy development in New Zealand. Studying information technology (IT)-based government initiatives in Gujarat, India, Madon (2005) identifies 'that IT-based initiatives can yield positive and effective governance reform, particularly where appropriate institutional support and activities couch the implementation of such IT-based solutions.' Madon *et al*. (2007) also reveal that effective implementation of government-based health information systems for the provision of services is impacted by the macro-level policy-making organs, thereby shaping the type of system that eventually gets developed. However, once such systems are in place they impact the efficacy of policy-making at those same macro-levels. As such, governance quality is influenced by the nature and type of IT-based solutions in place, but also influences the kinds of IT systems that get developed. Madon *et al*. (2007) thus posit that 'evaluation does help to understand the disjuncture between policy at the macro-level and implementation at the micro-level and to identify linkages between the two (p. 327).' In a twist of the general directionality used to examine the relationship between IT-based initiatives and country governance, Andersen *et al*. (2003) examine the impacts of governance on the diffusion of electronic commerce (e-commerce) initiatives in Denmark. They identify knowledge diffusion, economic incentives, electronic government, and regulation and control, as the four governance initiatives that foster development and diffusion of e-commerce within a country. In studying the impacts of culture on IT diffusion in developing countries in the Arab world, Straub, Loch and co-workers (Loch *et al*., 2000, 2003; Straub *et al*., 2001b) identify governance as a viable explanation for differences in the ways countries exploit information infrastructures.

OECD (1997) proposes that extensive information infrastructure may readily enhance government effectiveness and facilitate greater participation in the governance process by a nation's citizens. While studying teledensity in developing countries, Mbarika *et al*. (2002b) concluded that the level of teledensity correlates positively to governance quality. Most of the developing countries have been cited as having governance problems that in turn affect their progress toward economic prosperity and socio-economic development (Odedra *et al*., 1993; Odedra-Straub, 1993; Leftwich, 1995; Easterly & Levine, 1997; ECA, 1998; Meso & Duncan, 2000; LeBlanc *et al*., 2004). These countries, especially those categorized as least developed, are subject to significant internal unrest and civil strife (Easterly & Levine, 1997; LeBlanc *et al*., 2004).

It is critical that we learn more about the ways that information infrastructures contribute toward improving the quality of governance in these countries. These mechanisms include, among others:

(a) allowing greater access by the population to government services – especially via interactive on-line access;
(b) facilitating participation in the governance processes by a more diverse and larger segment of the population;
(c) dissolving the state's monopoly over news, information, and propaganda;
(d) rapidly disseminating news and information to the larger population;
(e) enhancing transparency and accountability of government officials via readily accessible information on governmental transactions;
(f) eliminating or minimizing barriers to participation in the country's economic markets; and
(g) promoting the rule of law.

Most of the past studies on information infrastructure have limited the scope of NII to the telecommunications infrastructure that made the Internet a reality (Philip, 1988; Dutta, 1992, 2001; Mbarika *et al*., 2001, 2002b). While these studies provide an initial understanding of the role of information infrastructure in economic advancement, studies by Sadowsky (1993, 1996), Byrd *et al*. (1995), Byrd & Turner (2000), Byrd (2001), Meso & Duncan (2000), Nidumolu *et al*. (1996), Tapscott (1996), and Miller *et al*. (1993) argue that a NII is more extensive

than just the Internet and its associated telecommunications backbone.

Selwyn & Brown (2000) note that most industrialized countries have witnessed the development of advanced information networks, usually under the rubric of creating a 'national information infrastructure.' They state that, in an organizational sense, such NII was envisioned as encompassing 'all computerized networks, applications and services that citizens can use to access, create, disseminate and utilize digital information (p. 662).'

Therefore, the development of the NII in practice has encompassed technologies as diverse as POTS (plain old telephone service), digital broadcasting, the Internet and other multimedia, in both the private and public sectors. In proposing a more-encompassing construct for NII, Meso & Duncan (2000) state:

> It is important to recognize that NII does not necessarily mean the Internet. Until this decade, NII throughout the world meant radio, newspapers, postal services, etc. These are still vital components of information infrastructure throughout the world … (p. 34).

Therefore, preceding research provides support for the inclusion of the Internet, personal computers, teledensity, radio density, television density, and newspaper circulation as technological constructs of the level of development of a nation's NII. For this reason, we employ this more-encompassing view of NII.

We posit that NII impacts governance and socio-economic development. The diagrammatic representation of the research model with hypotheses indicated is presented in Figure 1. We next derive and explain each hypothesis.

Relating NII to governance

Although the concept of governance has been extensively examined at the organizational level in published information and communication technology (ICT) research, it remains relatively recent where it concerns national-level or country-based ICT studies. In the international setting, governance refers to the manner in which power is exercised in the management of a country's economic and social resources for development (IBRD, 1998; Meso *et al*., 2006). The concept is gaining increasing focus as a national-level construct owing to the rapidly growing domain of e-government within the ICT research. Unfortunately, the definition of national-level governance remains increasingly limited to the narrow confines of e-government. For example, e-government may be perceived as a solution for 'jump-starting' dysfunctional and inefficient government operations, thereby yielding better governance (Goldsmith, 2005). In other words, the e-government systems implement governance. Chadwick & May (2003) posit that there are three models of governance observable in contemporary e-government implementations: managerial, consultative, and participatory. The managerial model of e-government has its focus on the dissemination of information to the citizens. In this context, effective governance is seen as providing the citizenry with pertinent information services in an open, transparent, and timely fashion. In the consultative model, effective governance is perceived as successfully obtaining feedback and opinions from the general public. The opinions may then be used in the policy-making process to inform and/or influence future government actions. As such, the role of e-government systems becomes that of soliciting and obtaining citizens' inputs. In the participatory model, governance is seen as open communications – the 'voicing of one's concerns' – where the opinions are not necessarily directed only to government but to all players within the governance communications space. Therefore, according to Chadwick & May (2003), e-government implementations in this realm foster the 'collaboration and information sharing among disparate stake holders.'

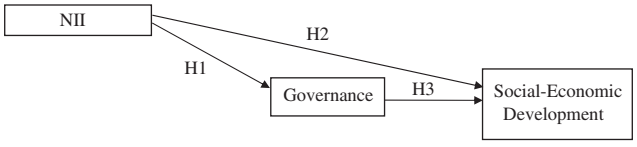

Figure 1 Research model and hypotheses.

However, governance is a broader construct than is perceived within e-government. According to Larmour (1995) governance connotes either of two things. The first is 'effective government.' This refers to the performance of a government as judged by conventional economic parameters such as fast rate of economic growth, low rates of poverty, high living standards, high GDP, etc. The second connotation of governance relates to the 'freedoms' accruing to a country's citizens owing to their government's actions. In this context, governance is seen as fostering democracy, legitimacy of public offices and institutions, limits to state power, and transparency in government operations.

This second perception of governance is also evident in Peters & Pierre (1998) who posit that governance is not the exclusive preserve of national governments. Rather, it entails multiple disparate players – citizenry, non-governmental organizations (NGOs), special-interest groups, etc., each seeking to satisfy their own interests. Therefore, governance is perceived as the dynamic interactions between and within public and private sectors, not relying simply on authority and sanctions of government (Stoker, 1998). As such, governance involves a coalition of diverse stakeholders from business, government, and NGOs working together to achieve mutually agreed-upon goals (King *et al*., 1994; King & Kraemer, 1995; Leftwich, 1995; Kazancigil, 1998; Stoker, 1998). Therefore, governance is related to the concept of autonomous self-governing networks of institutions. However, while drawing from this intellectual base, the concept of governance transcends government. Definitions of governance generally thrive on this blurring of boundaries

and focus attention more on end actions (Finkelstein, 1995).

Concepts of governance invoke responsibilities for tackling social and economic issues, and suggest the need for power dependence between all relevant institutions in order to precipitate collective actions. Therefore, as a concept, governance recognizes the capacity to get things done while not resting solely and simply on the power of government to command or flex its authority.

The NII in a country is expected to impact quality of governance. It can be argued that the nature of a country's information infrastructure can lead to increased levels of transparency and accountability (Park, 2002). Transparency refers to the degree of awareness by local citizens about all the key issues affecting the survival, performance, and well-being of the nation. When the larger majority of citizens are fully informed about these key issues and how they impact country's future, there is a higher probability that the actions and/or decisions of public institutions will be brought to scrutiny by various disparate stakeholders thereby leveraging the accountability of public socio-economic and government institutions within the economy (ECA, 1998). A transparent and accountable governance system clearly and publicly identifies parties responsible for particular decisions and actions, generating requisite pressure for high integrity and judicious execution of responsibility by civil servants and public agencies. In so doing, it discourages stakeholders and decision-makers from engaging in such vices as corruption (IBRD, 2001; Musa *et al*., 2005a). Given that easy and adequate access to information is made possible by a well-developed NII, the extent of development of this infrastructure plays a significant role in optimizing the governance system within a given nation. Therefore, we posit that information infrastructure impacts the quality of governance.

Advanced information infrastructure enhances the number of participants in all sectors of a country's economic, social, and political systems and the power–position of each participant (Alcantara, 1998; Jessop, 1998; Senarclens, 1998). In the advanced economies, key e-commerce market places such as E-Bay and Amazon.-Com have allowed a myriad of small businesses to gain access to geographically distant clients. In this example, the NII solution has contributed to an enhancement in the economic productivity for these countries by opening up new multi-billion economic sectors (Kraemer *et al*., 2005; Lin *et al*., 2007). In the lesser developed nations, the meteoric diffusion of cellular telephony and Internet technologies is beginning to impact economic productivity, by enhancing the density of economic networks and allowing many more individuals to participate in the formal economy (Meso *et al*, 2005; Musa *et al*., 2005b). The dynamic interaction between participants within and without each sector, the power-dependence of these participants, and the conflicting goals of each create an intricate governance network. Thus, the developments and the direction charted by each sector, as well as by the entire economy, will depend on consensus and collaborative efforts between all participants. In so doing, the governance of all sectors is enhanced (Jessop, 1998; Stoker, 1998).

The above discussion points to the proposition that the quality of country governance clearly depends on the information and collaborative networks made possible by the requisite information infrastructures. Therefore, we posit that information infrastructure is expected to impact the quality of a country's governance much like it has shaped and transformed the management of business enterprises. This line of thinking leads to our first hypothesis:

H1: *NII influences the quality of governance in developing countries*.

Relating NII to socio-economic development

The dissemination of NII in developing countries has continued to lag behind that of the industrialized world. Goodman (1991), Odedra *et al*. (1993), and Mbarika *et al*. (2002b), among others, report that the perceived value of information infrastructures in under-developed countries is far below that in industrialized nations. Reinforcing this point of view, Rose & Straub (1998) further identify government-based bottlenecks, specifically inept government policies, as key impediments to the development of information infrastructures in these countries. Nonetheless, all these researchers are unanimous in asserting that information infrastructures may have beneficial impacts on the socio-economic development of nations.

Literature on IT and development proposes that high levels of ICTs impact the standards of living, access to socio-economic development variables such as education and healthcare, and good governance (Meso & Duncan, 2000; IBRD, 2001; UNDP, 2006). As noted in UNCTAD's 2001 report on E-commerce and Development (UNCTAD, 2001):

> The introduction of wireless communications has not only expanded telephony in many developing countries, but also introduced wireless data services … For many people in developing countries, mobile handsets may be the first and main access route to information and communication technologies (ICTs), the Internet and e-commerce technologies (p. 89).

Published national development research points to the relevance and significance of technology in accelerating a nation's development, of which socio-economic development is only a part. Kraemer *et al*. (2005) and McCallum (1989), among others, indicate that technological progress positively influences the sustainable development of nations. In light of this, NII solutions are expected to contribute to socio-economic development. Hayami & Ogasawara (1999) reinforce this perception by stating that growth of national product depends predominantly on improved efficiencies (or technological

progress broadly defined) rather than on capital accumulation. Mowery *et al*. (1996, 1998) also acknowledge that the influence of international technology transfer on national development has rapidly increased, especially in the post-World War II era, and that this importation of technology has been the predominant cause of the meteoric development evidenced in most of the newly industrialized countries.

Studies on ICT diffusion in the Middle East (Goodman, 1991; Goodman & Green, 1992; Danowitz *et al*., 1995; Nidumolu *et al*., 1996; Rose & Straub, 1998; Loch *et al*., 2000, 2003; Straub *et al*., 2001b), Asia Pacific (Nidumolu & Goodman, 1993; Goodman *et al*., 1994; Dedrick & Kraemer, 1995; Goodman & Press, 1995; Thajchayapong *et al*., 1997; Walsham & Sahay, 1999; Barrett *et al*., 2001), South and Central America (Correa, 1992; Montealegre & Applegate, 1994; Mahmood *et al*., 1995; Montealegre, 1996, 1998, 1999; Ward, 2000; Tigre, 2001), and Sub-Saharan Africa (Odedra *et al*., 1993; Odedra-Straub, 1993; Goodman, 1994; Amoako, 1996; Damsgaard & Scheepers, 1999; Meso & Duncan, 2000; Mbarika *et al*., 2001, 2002a, b) have shown that there has been a very rapid growth in the diffusion of ICTs. Likewise, owing to the advent of the digital revolution, conventional broadcast technologies have also experienced such exponential growth (Kuhlen *et al*., 1996; Keyes, 1997; Lam, 1998; Mifflin, 1998; Paterson, 1998; Wresch, 1998, 2001; O'Sullivan, 1999; Weissman, 1999; Djerdjour & Patel, 2000; Fandy, 2000; Kayany & Yelsma, 2000; Phelps, 2000; Simha, 2000; Neuendorf *et al*., 2001). As the intensity of this diffusion increases, the use of NII for socio-economic development in less developed countries continues to receive much attention (Bhatnagar & Bjorn-Andersen, 1990; Wolcott *et al*., 1996; Goodman *et al*., 1998; Ein-Dor *et al*., 1999; Goodman, 2001; United Nations Conference on Trade and Development, 2001). Dutta (2001) performed a granger causality analysis of telecommunications infrastructure on economic development for 30 countries and found that the evidence for a causal link from levels of telecommunications infrastructure to economic activity is stronger than that for causality in the opposite direction. Further, this pattern of causality is evidenced by both developing and developed countries despite low indices of telecommunications infrastructure within developing countries. Dutta's findings provide impetus for examining the causal nature of the relationship between NII (not just telecommunications infrastructure) and socio-economic development, which normally goes hand in hand with economic development as a metric for national development.

In studying the 'digital divide,' Warschauer (2003) provides examples of practical interventions with respect to information infrastructure development affecting enhanced socio-economic development at the grassroots level in India. He reports:

> The Gyandoot (which translates to 'purveyor of knowledge') project in India was inexpensive to launch … and it is partly self-sustaining … In the nine months beginning in October 2001, the Gyandoot kiosks had some 21,300 users, 80 percent of whom had annual incomes of less than $300. The number of users is a small percentage of the population, but the benefits of the project, such as improved government services, eventually ripple outward to friends, families and co-workers. The magnitude of the Gyandoot success story remains to be determined. But the underlying approach – a combination of well-planned and low-cost infusions of technology with content development and educational campaigns targeted to social development – is surely a healthy alternative to projects that rely on planting computers and waiting for something to grow (p. 42).

Arguing that, as yet, very little is known about the long-term impact that ICTs may have on a country's social and cultural systems, Morales-Gomez & Melesse (1998) go on to assess the contribution of these technologies to economic and socio-economic development. They conclude that one of the greatest socio-economic development benefits derivable from the effective use of ICT is leveraging the reach, scope and quality of education and training to the citizens of a nation. Thus ICTs, they argue, have direct impacts on the socio-economic development of nation states in the long term.

Based on the above arguments, we expect this increase in NII technologies in those regions where all developing countries are found to correspond with increases in national development, particularly so with socio-economic development. Should this be the case, these infrastructures may be assisting in the progress of these countries toward socio-economic development. Therefore, we hypothesize that:

H2: *NII influences the level of socio-economic development in developing counties.*

Relating governance to socio-economic development

The review of literature also indicates that governance has an impact on sustainable socio-economic development. Kaufmann *et al*. (1999a, b) establish that there is a positive causal relationship between governance and economic development. Kaufmann *et al*. (1999a), Jessop (1998), Dutta (2001), and Kazancigil (1998) indicate that the quality of governance affects the rate of economic development.

Prior research has established that the quality of governance impacts the rate of a nation's socio-economic development (Leftwich, 1995; Jessop, 1998; Kazancigil, 1998; Kaufmann *et al*., 1999a; IBRD, 2002). As in the management of a firm, it is assumed that information is a valid resource that enables organizations and individuals to improve their effectiveness, efficiency, productivity, and overall competitiveness. For example, one of the key measures of good governance is political stability (defined as the measure of the degree of turbulence in a country). Literature on economic development and

international finance indicates that a particular country's level of political stability directly influences the risk associated with investing in a given country. The greater the degree of turbulence, the more risky it is to invest in the country (Sadowsky, 1993, 1996; Kaufmann *et al*., 1999a). Political stability also influences the level of engagement by local citizens in productive socio-economic activity (Kaufmann *et al*., 1999a). In situations of high political instability, citizens retire their productive resources, transfer these resources to more stable political environments, or covert these resources into assets that will protect them against possible loss of life and wealth. The net result is a drop in socio-economic development. Therefore, it is logical to presume that as the quality of governance rises, so does the level of socio-economic development. The hypothesis that follows logically is:

H3: *The quality of governance influences the level of socio-economic development in the developing countries*.

Research design

To empirically test the hypotheses in this study, we gathered archival data for each of the main constructs. This approach has the advantage of independent generation of variable values, and is thus more robust to the threat of common methods bias (Woszczynski & Whitman, 2004). Archival data also has limitations, one being that it is dependent on the assumptions that underlay the original data collection, as reported in Jarvenpaa (1990, 1991). We examine the threat of some of these assumptions later.

Hypotheses were tested via a cross-sectional analysis of 144 countries classified as middle- and low-income countries by the World Bank (IBRD, 2002) and as developing countries by the United Nations Development Program (UNDP) (UNDP, 2006). The primary sources of data were the International Telecommunication Union World Indices (ITU, 2007), the UNDP Human Development Report (UNDP, 2006) and the dataset for governance indices created by Kaufmann *et al*. (2007).

Operationalization of constructs

NII was operationalized as a formative construct measured by the density of ICTs within a country. The key ICT indicators that we included were telephone density, density of personal computers, Internet density, radio density, newspaper circulation density, and television density. The density is measured as the number of peripherals per 1000 population. These measures were adopted from the ITU (2007).

Governance was operationalized as a single formative construct comprising six indicators of governance originally presented in Kaufmann *et al*. (1999a). These measures are: Voice and Accountability, Political Instability and Violence, Government Effectiveness, Regulatory Burden, Graft, and Rule of Law. These measures have since been adopted by the World Bank and employed as indices of governance quality in the world development reports (IBRD, 2002). In a separate paper published in the same year, Kaufmann *et al*. (1999b) show that aggregated variables are richer and better predictors of governance than the individual governance measures that are currently used by a wide group of organizations. Further, they demonstrate that aggregating individual variables allows for the coverage of many more countries and for the standardization of the resulting measures, thereby facilitating cross-country comparative research.

Socio-economic development was operationalized using one formative latent variable comprising three indicators that make up the human development index. The indicators were life expectancy, education index, and per capita GDP calculated using the purchasing power parity (PPP) method. PPP calculates each country's GDP relative a selected standard, usually the U.S. dollar (UNDP, 2006).

Table 1 presents the descriptive statistics for the indicators to each latent variable used in the study. The table indicates that while the diffusion of personal computers remained relatively low at 3.23 computers per 1000 population, there was a relatively large diffusion of mobile phones – 25 per 1000 persons on average across the developing countries. This is consistent with the reports from ITU and other sources that have shown a meteoric rise in mobile phone ownership and usage in these countries. On average, there were 7.847 Internet access points per 1000 population and 3.8 land-line telephones per 1000 persons. When contrasted to the advanced nations, it is evident that the scope and extent of NII in the developing nations remains modest.

The data show that governance was also of moderate quality on average, with the mean scores on all the governance indicators being below 1.0. Socio-economic development measures were, on average, good. The mean scores of education, life expectancy and per capita GDP when adjusted for PPP were 0.753, 0.667, and 0.632, respectively. The best score a nation can attain on these indices is 1.0. Thus, these nations tended to register slightly above average performance when taken as a group. We note that these descriptive statistics provide an overall summary. There are nations that perform quite well on these indices while others report abysmal scores.

Analysis and results

The archival data for the 144 countries was analyzed using SPSS statistical software and the partial least squares (PLS) statistical analysis method as supported by the PLS software. All analysis was conducted on a personal computer. SPSS was used to run the descriptive statistics, assess construct validity and also to assess the reliability of the indicators. The hypotheses articulated by the research model were tested using PLS. PLS is a structural equation modeling technique that is well suited for highly complex predictive models (Fornell & Larcker, 1981; Joreskog & Wold, 1982; Chin & Todd, 1995;

Table 1 Descriptive statistics of indicators for the constructs

Construct	*Indicator*	*N*	*Minimum*	*Maximum*	*Mean*	*SD*
National information infrastructure	Telephone density (TL_DNST)	144	−1.751	20.680	3.816	4.833
	Internet density (INT_DNST)	144	0.000	55.343	7.847	11.041
	Personal computer density (PC_DNST)	144	0.000	31.911	3.232	5.573
	Television density (TV_DNST)	144	0	9285	206.15	1030.80
	Radio density (RADIO)	144	0	32.0	2.537	5.253
	Newspaper circulation density (NEWS)	144	0	88.4	15.904	19.759
Governance	Effectiveness of central government (GOV_EFF)	144	−1.427	1.442	0.030	0.481
	Regulatory quality (REG_QLT)	144	−2.398	1.567	−0.090	0.623
	Rule of law (RULE_LAW)	144	−1.181	1.769	−0.062	0.426
	Corruption control (CRP_CTRL)	144	−1.690	0.921	−0.014	0.425
	Voice and accountability (VOA)	144	−1.285	1.166	0.013	0.424
	Political stability (POL_STAB)	144	−2.514	2.078	−0.054	0.675
Socio-economic development	Purchasing power parity index (GDP_PPP)	144	0.317	0.941	0.632	0.159
	Life expectancy index (L_EXPNDX)	144	0.259	0.901	0.667	0.174
	Education index (ED_INDX)	144	0.255	0.973	0.753	0.177

Diamantopoulos & Winklhofer, 2001; Wixom & Watson, 2001; Gefen *et al*., 2003).

PLS has several strengths that make it appropriate for this study, including its ability to handle formative constructs, reputed robustness in handling small sample sizes, and missing values (Straub *et al*., 2002). As documented in Wixom & Watson (2001), the technique concurrently tests the psychometric properties of scales used to measure the variables in the model (i.e., the measurement model), and analyzes the strengths and directions of the relationships among the variables (i.e., the structural model). The path coefficients established by evaluating the research model in PLS allow u's to assess if there are relationships among the constructs representing NII, governance, and socio-economic development.

Assessment of the measurement model

The measurement model articulates the psychometric properties of scales used to measure the variables in the model. The specific tests used to assess this model include test for the research model's reliability, as well as tests for construct validity. The research model's reliability was tested by assessing the multicollinearity of the indicators for each construct. As summarized in Table 2, all the VIF values were below 3.3 which is the acceptable cut-off point (Nunnally, 1978; Diamantopoulos & Winklhofer, 2001; Jarvis *et al*., 2003; Petter *et al*., 2007).

Construct validity was assessed by examining the item weightings for the constructs (Jarvis *et al*., 2003). These results are presented in Table 3. It is worth noting that the indicators we selected to use have been accepted as standard measures for information infrastructure, governance, and social development, respectively. They have been in use for several years and are published annually by established global organizations (Kaufmann *et al*., 1999a; UNDP, 2006; ITU, 2007). Additionally,

Table 2 VIF scores for indicators in research model

Construct	*Indicator*	*VIF statistic*
National information infrastructure	Telephone density (TL_DNST)	1.524
	Internet density (INT_DNST)	1.986
	Personal computer density (PC_DNST)	1.663
	Television density (TV_DNST)	1.126
	Radio density (RADIO)	1.569
	Newspaper circulation density (NEWS)	1.646
Governance	Effectiveness of central government (GOV_EFF)	2.223
	Regulatory quality (REG_QLT)	1.725
	Rule of law (RULE_LAW)	1.507
	Corruption control (CRP_CTRL)	1.412
	Voice and accountability (VOA)	1.411
	Political stability (POL_STAB)	1.473
Socio-economic development	Purchasing power parity index (GDP_PPP)	2.983
	Life expectancy index (L_EXPNDX)	2.138
	Education index (ED_INDX)	1.583

Diamantopoulos & Winklhofer (2001) establish that the elements of a construct cannot be dropped if the content is valid. Petter *et al*. (2007) recommend that indicators

Table 3 Item weightings for model's constructs

Construct	*Indicator*	*Original sample*	*Sample mean*	*SD*	*SE*	*T-statistics*
National information infrastructure	Telephone density (TL_DNST)	0.240383	0.26119	0.157073	0.157073	1.530389
	Internet density (INT_DNST)	0.583559	0.58185	0.154336	0.154336	3.781094
	Personal computer density (PC_DNST)	0.368961	0.334576	0.193698	0.193698	1.904825
	Television density (TV_DNST)	−0.124268	−0.13751	0.090055	0.090055	1.379916
	Radio density (RADIO)	−0.303982	−0.28064	0.15568	0.15568	1.952611
	Newspaper circulation density (NEWS)	0.30866	0.269878	0.138794	0.138794	2.223874
Governance	Effectiveness of central government (GOV_EFF)	0.79072	0.641402	0.318159	0.318159	2.485298
	Regulatory quality (REG_QLT)	0.144831	0.279882	0.214394	0.214394	0.675537
	Rule of law (RULE_LAW)	0.071725	0.281735	0.196019	0.196019	0.365909
	Corruption control (CRP_CTRL)	0.249914	0.334356	0.220848	0.220848	1.13161
	Voice and accountability (VOA)	−0.128397	−0.22318	0.155598	0.155598	0.825186
	Political stability (POL_STAB)	−0.002318	−0.21299	0.166938	0.166938	0.013883
Socio-economic development	Purchasing power parity index (GDP_PPP)	0.808691	0.809745	0.255248	0.255248	3.168255
	Life expectancy index (L_EXPNDX)	0.089281	0.21695	0.157408	0.157408	0.567197
	Education index (ED_INDX)	0.161254	0.215133	0.151896	0.151896	1.06161

should be preserved even when they reflect non-significant weightings to their respective constructs where theorization of constructs affirms their content validity and dropping of such indicators would lead to a conceptual dilution the resultant construct. The theorization performed in the early parts of this paper reflects that the indicators used are adequately grounded in theory and are a core constituent of their respective constructors. Because of these reasons, we decided not to drop any of the indicators that were statistically insignificant in their contribution to each construct, since doing so would dilute the constructs so measured and threaten their content validity.

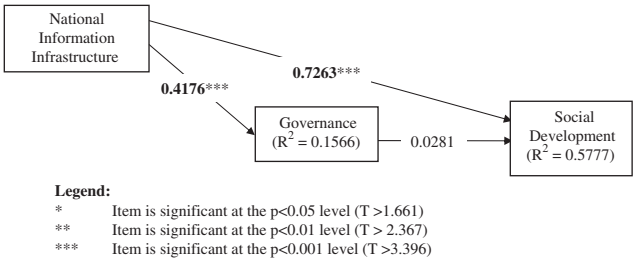

Figure 2 Results of the PLS analysis.

Assessment of the structural model

In PLS, the structural model tests the path coefficients and the R^2 values. Path coefficients represent the relationship between dependent and independent constructs. Results of the assessment of the structural model are indicated in Figure 2. The results for hypothesis testing are presented in Table 4. Our criteria for 'supported' is that the path coefficients should be strictly greater or equal to 0.20 and that the *P*-value for the path coefficient should be less than or equal to 0.05 (in other words, the t-value for the path coefficient should be greater than 1.96). Based on this criterion, two of the three hypotheses – **H1** and **H2** – were supported. However, hypothesis **H3** was not.

Probable reasons for lack of support of **H3** are presented in the discussion section. Power calculations are particularly relevant whenever the null is rejected (Baroudi & Orlikowski, 1989) and so we performed a power analysis for **H3**, the hypothesis that were not supported. The objective of this analysis was to determine the accuracy of this conclusion that the hypotheses are truly insignificant at the 0.05 alpha level. Power is the likelihood of a Type II error, and it requires parameters for sample size, alpha level and desired effect size. According to Cohen (1977), an effect size (d) of 0.2 or less is considered small, that of 0.5 is deemed moderate, while an effect size greater than 0.8 is deemed to be strong. Using the Gpower statistical program, the calculated power for the hypothesis was 0.8192, with a sample size of 144 and an effect size of 0.5. This, according to Cohen's threshold of 0.80 (1977), allows us to conclude that there is no Type II error and the lack of significance can be believed.

The structural model also allows us to assess the degree to which each dependent variable is explained by its respective independent variables. The measure used to capture this is the R^2. R^2 values represent the amount of variance explained by independent variables. There were two dependent variables in this study – socio-economic development and governance. Figure 2 presents the R^2 results for these variables. Both R^2 values were statistically significant ($P<0.050$) within the context of this study.

Table 4 Results of hypothesis testing with PLS

Hypothesis	*Original sample*	*Sample mean*	*SD*	*SE*	*T-statistics*	*Result*
H1: *NII* influences the quality of *governance* in developing countries.	0.335	0.439	0.086	0.086	3.923	Supported
H2: *NII* influences the level of *socio-economic development* in developing counties.	0.682	0.653	0.056	0.056	12.135	Supported
H3: The quality of *governance* influences the level of *socio-economic development* in the developing countries.	0.144	0.175	0.089	0.089	1.616	Not supported

Discussion of results

The results of this study reveal that NII has an influence on both governance and socio-economic development in the developing countries. The results also indicate that governance in and of itself has little direct impact on socio-economic development within the context of developing nations. This observation is refreshing as it is informative. Most of the past studies (Easterly & Levine, 1997; Dutta, 2001) indicate that there has been modest to no impact of governance on the improvement of the human development conditions in many developing nations. This is one reason why governance and the strengthening of governance institutions has become one of the key millennium development goals for the international development agencies (IBRD, 2002). However, it is interesting to note that NII influences governance. There has been an increase in concerted efforts to implement e-government systems with the view to easing and enhancing governmental service delivery to citizens, as well as enhancing access to information by citizens. Our research model indicates that if these initiatives are done well, then they stand to leverage the socio-economic development of member nations.

It is also interesting to note that NII has direct bearing on the socio-economic development of member nations. Also supporting the point of view that IT infrastructure influences socio-economic development are Tapscott (1996), Mbarika *et al*. (2002a), and Meso *et al*. (2006), among others. Past empirical information systems research points to the fact that information infrastructure has positive effects on socio-economic development – both directly, and through its effects on governance (Finkelstein, 1995; Dyer, 1996; Jessop, 1998; Farazmand, 1999; Kaufmann *et al*., 1999a; Durant, 2000; Hart, 2001; Islam 2001; Musa *et al*., 2005a; Meso *et al*., 2006). Therefore, the results of this study are in keeping with previous studies. This may be a reflection of the contributory effects of NII in providing 'new' information and opportunities to the citizens of these nations. In allowing for freer and easier communication and collaboration with other parties, technologies such as mobile cell-phones and Internet cyber-cafes are empowering citizens of these nations. In providing them with access to hitherto unreachable markets and 'new' market information, these technologies are shrinking the distance between suppliers and consumers and squeezing out the inefficiencies attributed to middlemen and other trade intermediaries. The very nature of NII may also be contributing to increases in literacy levels, and a change in hygienic behavior, owing to educational information, that contributes to a reduction in infectious diseases.

We must point out that this study was structured as a quantitative analysis of the impacts of NII on governance and socio-economic development. While we acknowledge that there may be unintended consequences of NII, or that the impacts of misusing NII on both governance and socio-economic development may indeed by deleterious, we were not able to measure these using the constructs and methods employed in this study. This study's scope did not allow us to examine the specific ways that NII is being used. We view the study of actual usage of NII as an interesting and necessary extension of this study. An examination of the precise usage is best conducted in in-depth field studies that we propose need to be undertaken to provide further verification of the results observed in this study.

In summary, the study's results provide strong empirical support for the research model in this study. The tests confirmed the model's rigor and relevance in all its antecedents. The results also provide grounding for in-depth studies in the specific usage of NII within various countries and how such usage impacts both governance and socio-economic development. In this regard, the results provide empirically validated information on the value (perhaps potential value) of NII solutions within the context of developing nations. What is important about the results from this study is that they provide empirical support for the impacts of NII in the advancement of developing nations. The results indicate that the development of information infrastructures should impact the quality of governance and socio-economic development in the developing countries. Therefore, developing countries stand to benefit by leveraging their NII.

Although several past studies such as Durant (2000), Dyer (1996), Farazmand (1999), Finkelstein (1995), Hart (2001), Jessop (1998), and Kaufmann *et al*. (1999a) have suggested that governance is a significant determinant and contributor to socio-economic development in

developing countries, our study results did not elicit a similar result. However, the relationship between governance and the socio-economic development construct was in the expected direction (i.e., governance influences socio-economic development). Several reasons can explain this, but these remain to be empirically validated. First, the strength of this relationship may have been weakened by the fact that this study limited itself to developing countries. It may be that because the vast majority of low-scoring countries on the governance scale are developing nations, the linear association between governance quality and socio-economic development is suppressed. We note that published research examining the effects of good governance on socio-economic development has either included a balanced sample of both the developed and the developing nations (Dyer, 1996; Finkelstein, 1995; Jessop, 1998; Farazmand, 1999; Kaufmann *et al*., 1999a; Durant, 2000; Hart, 2001; Islam, 2001), or has taken the format of a single-nation case-study (Islam, 2001). This limitation in our study may have caused the insignificant governance to socio-economic development linkage.

Second, archival developmental data for underdeveloped countries still suffers from missing data values. Our dataset reveals that most of missing data were in variables that were used to operationalize socio-economic development. While the statistical tool PLS graph is capable of handling cases that have missing data, it is likely that more significant results would have been observed had these cases been fewer in number. It is gratifying, though to observe that despite these limitations, the directionality of the relationship was consistent with previous research.

Therefore, while our study did not come to the expected conclusions with respect to the impacts of governance on socio-economic development, we can state that our findings are in the same direction as past studies where this relationship was found to be significant. This allows us to infer that adequate investments in information infrastructure not only enhance quality of governance, but also contribute to the enhancement of governance's effects on socio-economic development. In this light, our finding concurs with Dutta's study (2001).

Conclusion

This research examined the nature of the relationship between NII and governance within developing countries. The results partially confirm that the NII matters. It is significantly related to governance. Moreover, higher levels of NII dissemination relate to significantly better performance in governance. The findings in this paper confirm the belief that concerted efforts to increase the levels of NII in developing countries is a step in the right direction. Through the direct impacts of NII on governance, enhancing NII levels in these countries should also contribute to the eventual improvement in the quality of governance.

Enhancement of the NII also leads to improvements in the levels of socio-economic development. Therefore, enhancing the information infrastructure in these countries is bound to contribute significantly toward the acceleration of sustainable socio-economic development and the consequent integration of these countries into the global economy. However, much transformation is needed in the information infrastructures of these countries to foster the benefits that can be reaped from extensive NII.

Historically, poor governance (coupled with dictatorial regimes) has been a major characteristic of developing countries. Most of these countries have traditionally turned to the 'West' (Europe or North America) for a 'hand-out' to address problems of poor governance through loans as a step to imperfectly resolve these problems. Our study sets forth the proposition that the broad diffusion of NII may be a starting point, or perhaps a necessary but not sufficient condition, toward sustainable improvement of governance in developing countries. We neither claim that NII will amount to successful governance, nor that it will instantly transform poorly governed nations into role models of exceptional governance. What we do posit is that capabilities (such as electronic voting, web-based reporting of government spending, etc.) made possible by information infrastructures present a possible avenue for the effective delivery of government services, operationalization of functional and sustainable governance frameworks, and the implementation of efficient government operations and for the sustainable socio-economic development of developing nations.

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