

# Relationship between ICT Maturity and Global Competitiveness: A Two-Wheel Causality Model

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## ABSTRACT

In an era marked by globalization, intense competition and huge advents in information and communication technologies (ICT), many organizations have adopted and deployed ICT applications that would provide them with sustainable global competitive advantages. Most evidence of such ICT impact is at the firm level; the global impact of ICT at the country level has not been studied and incorporated within an integrated theoretical framework. More specifically, questions like: *What are the ICT drivers that would help in the attainment of sustainable global competitiveness at the country level, and do different ICT resources lead to different competitiveness levels, or are differences accounted for by other factors* – need to be addressed. This paper is an attempt to answer these questions through the development of a model to depict the strategic impact of a country's ICT resources on global competitiveness. The two-wheel model is symbolization for a dynamic model where one wheel (a country's ICT maturity) pushes the other (Global Competitiveness). The model is based on literature review and study of models provided by previous researchers regarding the impact of ICT on the performance of international firms. The application of the model includes: (a) identification of the strategic ICT factors that would help counties attain better ranks in the global competitiveness spectrum; (b) examining the causality relationship between ICT maturity and global competitiveness; and (c) derivation of global competitiveness rankings for countries based on their ICT maturity levels. This contribution is believed to be useful to practitioners, academicians, and researchers interested in the ICT-Global Competitiveness research stream.

**Keywords:** ICT maturity, Global Competitiveness, Two-Wheel Model, causal relationship, Grid Analysis.

## INTRODUCTION

Today's era is marked by globalization. This trend poses both opportunities and challenges to organizations and nations in their attempts to achieve competitiveness and growth. Information and communication technologies (ICT) are considered drivers of growth (OECD, 2001). The leading question in this era would therefore address the ways and the extent to which managers of organizations and institutional frameworks of countries would support and make use of the ICT potential. In fact, with the recent advents in this part of technology, ICT have become increasingly diffused at the firm, industry, national, and global levels. This resulted in an impetus not only in bringing companies and industries together, but also in linking countries within a global networked model.

In terms of global expansion and achievement of global competitiveness, ICT can either be an enabler for or an impediment against the realization of these goals. Of course, this depends to a great extent on a variety of contextual, technological, and institutional factors, as well as on the strategies followed for adopting and implementing these technologies. Consequently, in a global, highly competitive, and knowledge-based economy, it is imperative for organizations and countries' governments to understand the dynamic and significant role that ICT play today. In fact, organizations and nations of the 21<sup>st</sup> century are operating in environments that make it imperative for managers and country strategists to have knowledge well-shared, organized, and collaborated (Shea and Lewis, 2007) in an efficient and effective way. This highlights the importance of ICT maturity as an enabler of resource reconfiguration and as an enhancer of dynamic capabilities aimed towards the achievement of higher levels of competitive advantage.

It is worth emphasizing at this point that ICT maturity is not the same as IT adoption. As mentioned in the literature review conducted by Mahmood et al (2001), the term has been defined differently in different studies. Nevertheless, all the definitions emphasized the idea that it is the actual use of ICT that is expected to help organizations and nations achieve global competitiveness. The importance of this relationship has been clearly revealed in an extensive body of IS research.

Previous research related to global IT and the drivers by which global IT help organizations achieve their global objectives and strategies has grown remarkably since the dawn of globalization emerged as a challenge and an inescapable fact in the business world. The major themes beyond this research stream along with the major findings are listed below:

### ***At the Firm Level***

- Technological compatibility and ease of adoption are the major drivers for technology adoption and use (Di Benedetto et al, 2003).
- Furthermore, a firm's environment, level of technology diffusion, and the IT applications supporting the business operations are major drivers for the firm to enhance its global business (Desai et al, 2004).
- Within specific countries, a study on IT adoption in Italian firms show that firm size, geographical location, R&D activity, and functional composition of the workforce are among the significant determinants of IT adoption (Giunta and Trivieri, 2007). A similar study in Spain shows similar results, but with an additional emphasis on skilled workforce, quality control system, and work force education (Moriones and Lera-Lopez, 2007). In a similar vein, a very recent study in information technology diffusion at the firm level in Portugal emphasizes that ICT diffusion is determined by important drivers, such as:

firm size, workforce skills, technological capabilities, outsourcing partner usage, as well as the extent of ICT use (Martins and Oliveira, 2008).

#### ***At the Country Level***

- At the country level, differences in ICT implementation among developed countries – for example, the lag of Europe behind the USA in terms of ICT diffusion – are partly attributed to structural cross-country differences, such as economic and technical characteristics (Cette et al, 2005) as well as labor contributions and IT investment level (Daveri, 2001).
- In other contexts, such as developed vs. developing countries (e.g. USA vs. China), different levels of organizational adoption of e-business attribute to factors like the lag of Chinese firms to adopt e-business needed technologies, the more extensive use of Internet and ICT by US firms, and the type of regulations imposed by the Chinese government (Xu et al, 2004).
- Moreover, different approaches to developing e-business in two developing countries (China and India) having the same access to technology are ascribed to differences in approaches to utilizing the technology. These differences in approaches are related to differences in government initiatives, infrastructure, and culture, among others (Raven et al, 2007).
- In addition, ICT adoption and use in a global environment are influenced by different cultures, legal systems, information technology infrastructure, and the availability of IT skilled labor (Dasgupta et al, 1999).
- Finally, recent advancements in ICT resulted in effective means of collaboration, mainly in the form of virtual communities. These virtual communities proved to significantly raise the efficiency and effectiveness levels at the intra- and inter-organizational levels (Tan, 2007).

### **STATEMENT OF PROBLEM**

The growing technological developments of broadband access have the potential of providing global organizations and nations as a whole with significant social and economic opportunities. The Global Competitiveness and the Global IT reports clearly show so many cases, where top ranked countries in technology index and networked readiness are also top ranked in global competitiveness index such as Denmark, USA, Switzerland, and Sweden (Global IT report, 2007-2008, Global Competitiveness Report, 2008). Other examples would be Singapore and Hong Kong. These two countries are well known to have rapidly growing trading platforms that are attributed to their high levels of e-readiness (Mutula and van Brakel, 2006), which is an aspect of ICT maturity.

Despite this relationship and its implications for global organizations and countries, there is a lack of substantial research work that relates the ICT indicators to the global competitiveness attributes in a dynamic form. As important as it is, the previous research stream has been mainly confined to the firm level (Li et al, 2007; Melville et al, 2004) with a very narrow focus on the country context. Even research that took into consideration the country context mainly emphasized IT-globalization analysis in one country (Giunta and Triviei, 2007; Martins and Oliveira, 2008; and Mariones and Lopez, 2007), or a comparative analysis of the IT practices in two or three countries (Raven et al, 2007 and Xu et al, 2004).

The very few research papers that conducted a cross-country comparison or analysis emphasized only specific country-related factors that could be associated to ICT or Internet diffusion (Gibbs et al, 2003; Gibbs and Kraemer, 2004; and Zhu et al,

2006). Also, previous research offered remarkable contributions in examining the socio-economic factors that influence the technological levels in a certain country (Azari & Pick, 2005) or in assessing the role of environment and policy factors in shaping global ICT diffusion across countries (Gibbs et al, 2003). However, comprehensive studies of how ICT maturity factors dynamically contribute to the various attributes of global competitiveness have been lacking. In fact, while the questions: “*why do some countries have better ICT use and higher diffusion levels than other countries*” and “*what are the determinants of global competitiveness*” have been answered by previous research, there are certain question that have been left unanswered, for example, *why do some countries with valuable ICT resources fail to achieve high levels of global competitiveness*, and, *how do the strategies – followed by a certain country’s government and global organizations to promote ICT diffusion and use – get reflected in the various global competitiveness attributes?*

This research intends to cover this gap, model ICT maturity, define the characteristics of global competitiveness, and depict the potential causal relationship between ICT maturity and global competitiveness.

## **STATEMENT OF OBJECTIVE**

This paper has three primary aims. The first is to present an integrated synthesis of the ICT maturity socio-technical dimensions as well as the global competitiveness attributes. The second is to propose a model of how strategies and factors related to the enhancement of ICT maturity may become reflected in global competitiveness outcomes. Finally, the third objective is to provide a conceptual foundation for empirical research intending to investigate and explain the links between ICT maturity dimensions and outcomes manifested in competitiveness indicators.

Emphasizing a holistic and dynamic ICT-Global competitiveness framework is anticipated to make this paper mission critical to scholars, government analysts, and ICT developers and strategists. To start with, scholars can use the framework as a foundation for assessing the contribution level of each socio-technical factor in the achievement of ICT maturity, and consequently, on each of the attributes of global competitiveness as well as on the construct as a whole. As for government analysts, they will find in this framework a powerful means to identify, based on a country’s set of economic and socio-technical resources and dynamic capabilities, the factors that should be more emphasized than others in order to yield higher levels of ICT maturity and, as a result, better global competitiveness ranks. Finally, to support the country strategy-technology fit, ICT designers and developers can find the model useful as it allows linking every ICT maturity-enhancement strategy or tool to the ICT performance and to the country’s global competitiveness objective.

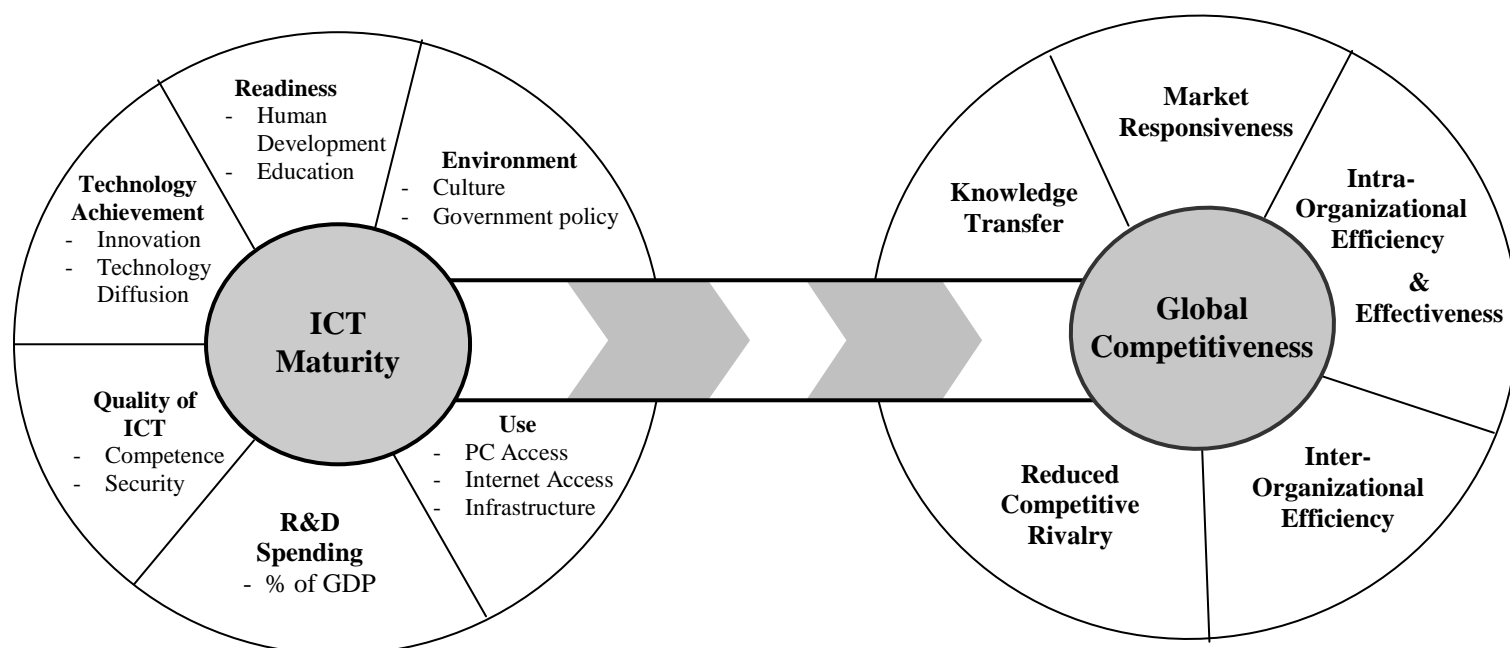
## **THE TWO-WHEEL MODEL DEVELOPMENT**

The Two-Wheel model is based on a theoretical foundation derived from three theoretical perspectives: the diffusion of innovation (DOI) theory (Rogers, 1995), the technology-organization-environment (TOE) framework (Tornatzky and Fleischer, 1990), and Delone and Mclean IS success model (Delone and McLean, 2003). An illustration of the Two-Wheel model is depicted in Figure 1. The model has three important characteristics:

1. First, it is an integrated socio-technical model. The model synthesizes the majority of the social and technical elements that are mentioned in the literature as being important determinants of ICT maturity. Based on the Delone and McLean model (Delone and McLean, 2003), the ICT maturity part of the Two-Wheel model

emphasizes ICT quality as a major element in the determination of ICT maturity, whereas the net benefit would be represented by the global competitiveness that a country can achieve as a result of its ICT contribution. The Two-Wheel model also emphasizes the social characteristics, mainly the cultural environment, readiness, government policies, technology achievement, as well as R&D spending, derived from both the DOI model and the TOE framework, to reflect the innovation (ICT) and environmental characteristics that play a role in the realization of ICT maturity.

**Figure 1** The Two-Wheel Model: ICT maturity and global competitiveness



2. Second, it is a dynamic model. The ICT maturity wheel is envisioned as a major catalyst for pushing forward the global competitiveness wheel. Moreover, working on any of the factors influencing ICT maturity is expected to influence one or more of the global competitiveness manifests comprising the global competitiveness wheel.
3. Third, it is a proactive model. Understanding the environmental factors – both domestic and global – along with the available resource endowments, a country's strategists can effect certain policies or initiate certain agreements that would improve the ICT maturity levels and, in turn, realize better levels in global competitiveness.

## MODEL COMPONENTS

While the overall Two-Wheel model will portray the potential causal relationship between ICT maturity and global competitiveness, each of the wheels will focus on a certain issue, as discussed below.

### 1. First Wheel: ICT Maturity

The ICT maturity is the core component of the first wheel of the model. At the firm level, this dimension was found to be significantly determined by the extent of IT use in organizations as well as the size of organizations (Mahmood et al, 2001), as well as

infrastructure and environmental aspects (Karimi et al, 1996). At the same time, it was reported to have an effect on organizational performance and productivity. At a broader level, ICT maturity was found to be a key determinant of organizations' willingness to use ICT as a strategic response to globalization challenges (Karimi et al, 1996) and as a means for international organizations and countries to attain competitive advantage.

### ***1.1. Environment***

The environment element in the Two-Wheel model includes two factors: (a) the cultural environment, and (b) the government policies. As for culture, its impact on any national or international related strategy can not be ignored. This is because global operations have to take into consideration cultural diversity. A huge body of research work investigated and emphasized the significant relationship between culture or cross-cultural differences and the differences in the levels of ICT adoption, diffusion, and use along countries (Gallivan and Srite, 2005; Srite, 2006).

In addition to this, the role of the government policy in the process of ICT diffusion enhancement can not be underestimated. Barretto et al (2007) conferred the position of the Brazilian government, which considers strengthening sharing as the main element of the digital inclusion process in Brazil. Also, the role of institutional systems in enhancing education and regulatory policies play a substantial role in global Internet diffusion (Zhao et al, 2007).

### ***1.2. Readiness***

This measure includes a country's human ICT readiness and education level. As for human ICT readiness, this sub-factor refers to availability of the most sought for ICT skills, technical support adequacy, diversity of staff ICT educational qualifications and skills, and professional usage of ICT resources and tools (Mutula and van Brakel, 2006).

The second element in this factor is the level of formal and IT education level in a country. Higher education levels are expected to promote the ICT optimal diffusion and use, technical progress, as well as R&D activities (Clark and Guy, 1998; Chandra et al, 2006; and World Economic Forum, 2008).

### ***1.3. Technology Achievement***

United Nations Public Administration Network (UNPAN) has developed a technology achievement index (TAI), which is a composite index of technological achievement that reflects the level of technological capacity of a country to participate in and benefit from the interconnected globe (Desai et al, 2002). The index also helps a country benchmark its technological progress against other countries' technological best practices and strategies

### ***1.4. ICT Quality***

ICT quality is emphasized by several researchers as a means for enhancing ICT diffusion, penetration, and use. The measure appears as a major antecedent for ICT adoption and use in Delone and McLean Model of IS Success (Delone and McLean, 2003), and it comprises four scales: convenience of access, flexibility of the system, integration of the system, and response time). Moreover, compliance with quality ICT international standards and online information security – two important ingredients of ICT quality – are pointed out as important elements for assessing e-readiness among countries (Mutula and van Brakel, 2006). In this study ICT quality is defined as comprising IT competence (Lee et al, 2007) and security.

### ***1.5. R&D Spending***

Many developed countries aiming towards achieving higher levels of global competitiveness have realized the importance of R&D as a driver of the new economy. These countries, such as USA, Belgium, Finland, Sweden, and Switzerland maintain a research base that is closely related to the commercialization, diffusion, and proper use of ICT (Atkinson, 2007).

The importance of R&D is equally important to enhance the competitiveness levels of developing countries. This is realized by the efforts a developing country undertakes in order

to attract foreign innovation-based activities. A case in point could be China, where R&D investments by US firms in China increased from \$5 million in 1994 to \$506 million in 2000 (Atkinson, 2007).

### ***1.6. Use***

According to the technology acceptance model, one of the factors that play a pivotal role in ICT implementation is realizing the intended level of usage of these technologies (Amoako-Gyampah and Salam, 2004). This important factor includes affordability of Internet access, broadband access availability, as well as ease of access and use of the network. This includes to a large extent the significant role of infrastructure. In the context of this study, it refers, among other things, to internet connectivity, high bandwidth for accessing the network, and sufficiency and competence of national power grid (Mutula and van Brakel, 2006).

## **2. Second Wheel: Global Competitiveness**

Since earlier times, researchers and scholars have shown an interest in answering the basic question, “why do some nations succeed and others fail in international competition” (Porter, 1990). In this study, the emphasis is on ICT maturity, a factor anticipated to have an impact on shaping, enhancing, and promoting the attributes of global competitiveness.

### ***2.1. Knowledge Transfer***

The importance of knowledge transfer was emanated by the increasing size of global competition, increasing scope of global companies, and increasing ICT capabilities (Niederman, 2005). To enhance this capability, the Internet and the ICT resources can be used to support knowledge conversion processes (de Carvalho and Ferreira, 2001).

### ***2.2. Market Responsiveness***

Advances in the Internet and ICT resources have enabled companies at the national, regional, and global levels to be flexible and responsive to changing market requirements (Gunasekaran and Ngai, 2004). With environmental uncertainty, ICT has proved to be a substantial ingredient in a organization’s ability to detect and respond to market rapid changes (Tallon, 2008).

### ***2.3. Reduced Competitive Rivalry***

ICT contributes to a significant alteration of competitive forces (Rivard et al, 2006). This contribution is manifested by lower error rates (Azevedo and Ferreira, 2007), as well as lower costs, differentiated products, services, and operations.

### ***2.4. Inter-organizational Efficiency and Effectiveness***

ICT infrastructure has a big role to play in supporting inter-organizational coordination. Global organizations from a vast array of sectors have benefited from the network-enabled connectivity and interactivity provided by the Internet and advanced ICT. This is because such advances have enabled a more efficient and effective information exchange (Zhu et al, 2004) as well as better coordination mechanisms and interconnectedness (Yeniyurt et al, 2005).

### ***2.5. Intra-Organizational Efficiency***

ICT proved to be a major means for streamlining organizational operations. In a global context, e-logistics and virtual communities have added to the efficiency and effectiveness of a global firm’s operations. Previous research highlighted the improvement in operating efficiencies and reduction in operating concerns (Zhu et al, 2004) as well as in improving inter-functional coordination (Yeniyurt, 2005).

## **Relationship between the Two Wheels**

As mentioned earlier, the two-wheel concept is meant to represent a dynamic - and a potential causal - relationship between ICT maturity and global competitiveness. In reference to the resource based view model, ICT can be viewed as a resource and as an enabler of dynamic capabilities that have the potential to provide the firm with competitive advantage at the industry, national, and global levels (Wade and Hulland, 2004). The Global Competitiveness report mentions that the global competitiveness index is a function of 12 factors “pillars”,

including among others: institutions, infrastructure, innovation, higher education and training, and technological readiness (World Economic Forum, 2008). Furthermore, ICT capabilities, including, for example, ICT infrastructure, technically skilled human resources, and IT 'intangibles', are sources of competitive advantage (Rivard et al, 2006). In the proposed Two-Wheel model, these factors are included as enablers of ICT maturity, which in turn would lead to global competitiveness.

Indeed, ICT is nowadays considered as a pivotal component of worldwide corporate and national strategies. This was confirmed by earlier research (Palvia, 1997), which measured the strategic global impact of IT on an international firm. Moreover, a transnational organization has three competitive requirements: efficiency, responsiveness, and learning, which can be met by appropriate and advanced ICTs (Boudreau et al, 1998). These results are also corroborated by more recent studies showing that ICT has a strong impact on operational efficiency and flexibility (Batra, 2006), with flexibility here indicating market responsiveness, better customer service, and more streamlined business processes. The Two-Wheel model also encompasses these attributes in the global competitiveness wheel.

## **CONCLUSION, IMPLICATIONS, AND LIMITATIONS**

Today's environment is dynamic and complex. Within this environment, hardly a day passes without analysts and decision makers at the organizational, industry, or country levels thinking of strategies to deal with the opportunities and threats posed by this environment and to efficiently and effectively use their resources and dynamic capabilities. Almost all over the globe, managers, economists, and governments are putting relentless efforts to achieve and maintain competitiveness at the national, regional, and international levels.

In such environment, ICT adoption and diffusion strategies do, and will, play a crucial strategic role in the achievement of global competitiveness. Consequently, it is prudent for global companies and for countries' governments to understand the factors that are associated with a successful ICT adoption, implementation, and use.

Inquiry into these factors and into their potential causal relationship to the indicators of global competitiveness is of key importance to decision makers of countries aiming at attaining better ranks in the global competitiveness scale. As a result, the holistic and dynamic model proposed in this study is mission critical and has a strong potential to provide three major benefits. For the scholars and global IT researchers, it offers substantially a powerful means to predict outcomes pertinent to global competitiveness. A second benefit would be for the designers and developers of global ICT infrastructures, tools, and applications, since a global platform would be different from organizational or local platforms. A third benefit may accrue to country level analysts and government strategists who try to identify the optimal means for achieving ICT maturity and deploying it for the achievement of global competitiveness. For example, light may be shed on the policies set by a certain country's government to promote R&D spending levels as a means to enhance better development and use of ICT. Also, the importance of, say, providing people with better access to formal and IT education may become more apparent. In addition, the effect of propagating an ICT-related factor on any global competitiveness indicator will be better examined, assessed, and benchmarked against the best practices of other countries.

Besides these contributions, the study presented herein has certain limitations. To start with, while the model mentions a dynamic interaction between ICT maturity and global competitiveness with the ICT maturity being the initiating factor, it ignores the possibility of a reciprocal effect. The effects of multinational activities on the ICT diffusion and use strategy (Moon et al, 1998) are not shown in the model. In other words, if a country could achieve alignment in collaborative practices with another country, it might speed up its ICT penetration and use levels to better reap the benefits of this alignment (Mankvold, 2005). For example, investment in supply chain management systems and collaborative commerce technologies could be a response to certain global agreements or successful and promising collaborative efforts between countries. This is because if the diffusion of innovation theory is



considered, and the global competitiveness is the objective a country aims to achieve, then the relative advantage of the country's efforts to achieve this objective will influence the ICT strategies the country adopts.

Also, global factors influencing the ICT maturity, like international barriers to the adoption of certain technologies from other countries need to be addressed. Other issues could be security concerns, partner non-readiness, or national policies of other countries that will make the adoption of certain technologies to deal with that country rather costly.

Moreover, the interaction between a country's socio-technical factors and other country-related factors, such as GDP, tax subsidies, country risk analysis was not established. While these were not included to focus the lens on technological and human factors related to ICT maturity, their inclusion could contribute to a wider perspective to the matter.

As a response to these limitations, further research can build on the proposed Two-Wheel model to study the influence that global competitiveness factors have on speeding up the wheel of ICT diffusion and penetration. In addition, future researchers can extend the ICT maturity related factors to include, beside the country-related socio-technical factors, other country factors that are believed to influence the ICT-maturity status in a country. Moreover, since it is a global networked economy, future research is recommended to take global factors into consideration.

Finally, our study provides a conceptual, holistic and dynamic model for understanding the socio-technical factors related to ICT maturity, and how these factors can lead to global competitiveness. In fact, in a globally competing environment, ICT adoption, diffusion, and use strategies do, and will, play a crucial strategic role in the achievement of global competitive advantage. These technologies are mostly everywhere; the key, however, lies in how to use them for winning better ranks in the global competitiveness ladder. This is because as Sun Tzu wrote thousands of years ago:

*All men can see the tactics whereby I conquer, but what none can see is the strategy out of which great victory is evolved.*

Only by getting committed to this challenge will countries and their governments have the means they and their organizations need to attain ICT maturity, and consequently, global competitiveness leadership!

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