By Contribution

ICT Impact on Contribution of Human Resource Development to Economic Growth

Vahid Rangriz & M. G. Basava Raja

This paper reports on a research model to empirically examine the relations of education quality, on-the-job training, and the adulthood of Information and Communications Technology (ICT) use by persons, commercials and administrations, and Gross Domestic Product (GDP) per capita across 112 countries. The findings designate that education quality is definitely related to GDP per capita, while on-the-job training is not. Education quality is definitely related to ICT use by persons and administrations, but weakly to ICT use by commercial. On-the-job training, though, is definitely related to all the three areas of ICT use. The paper distinctly analyses the countries with upper and lower levels of GDP per capita and finds both resemblances and changes. Healthy compound consistencies and R^2s are obtained in all the analyses.

Vahid Rangriz is a Ph.D Scholar in Department of Economics, Mysore University. E-mail: vahidrangriz @gmail.com. ***M. G. BasavaRaja*** is Professor of Economics & Course Coordinator, Sir M.V.P.G Centre, University of Mysore, Mysore-570009. E-mail: pgcentremandya@yahoo.com

Introduction

In the current socioeconomic development theory and practice, at least two significant changes in emphasis have happened. One, there is a rehabilitated emphasis on human resource development, which has led to a reemphasis on the role of education and training in economic development (Chacko 2005). Two, the importance of Information and Communication Technologies (ICT) use has been recognised as key to the transformation of socio-economies (Baliamoune-Lutz 2003, Corea 2007). Certainly, current ICT trends such as e-commercial and e-administration have been quoted as routes to wealth creation (Amit & Zott 2001) and economic development. The proper roles and real effects of information technology in the dynamics of socioeconomic growth continue controversial, though. Certainly, it has been contended that "economic and social theory converges to the proposal that ICT dispersal and strengthening of information activities do not lead deterministically to economic development" (Avgerou 1998). Consequently, it is significant to conduct global investigations into the roles and interaction of human resource develop-

ment, ICT usage in the areas of citizens, commercial, and administration, and national economic prosperity.

We develop and test a research model that empirically investigates the relations of education quality, on-the-job training, ICT use maturity in three areas (personal, commercial, and administration), and Gross Domestic Product (GDP) per capita across 112 countries. Specifically, we look at the statistically direct relations of education quality and of on-the-job training with ICT usage by persons, commercial, and administration, and with nations' GDP per capita. We also examine the unintended relations of education quality and on-the-job training with GDP per capita through nations' stages of personal, commercial, and administration ICT use.

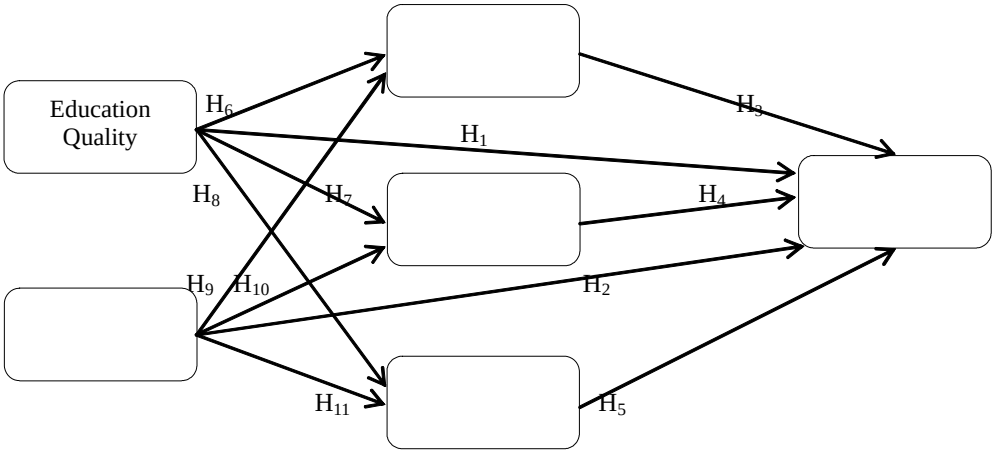
The most pronounced effects are the direct connotation of education quality and on-the-job training with the mainstream of ICT usage areas.

Our research propositions and consistent model are tested using country-level data made available by the World Economic Forum (WEF), the International Telecommunications Union (ITU), and the World Bank, covering 112 countries. For analysis, this sample size is too small to test the model using a maximum likelihood physical equation modelling technique, and so we use Partial Least Squares (PLS) for predictive, exploratory analysis. All the constructs (latent variables) have very good compound reliability scores (all greater than .9), many significant model paths are important, and the R^2s for the four endogenous variables—the three ICT use areas of personal, commercial, and administration, and the GDP per capita—are healthy. The most pronounced effects are the direct connotation of education quality and on-the-job training with the mainstream of ICT usage areas. This is the case for both countries with upper and lower stages of GDP per capita analysed distinctly and overall. Group changes happen for direct relations with GDP per capita where education quality is important in upper stages of GDP per capita countries and on-the-job training is important in lower stages of GDP per capita countries. The relatives of ICT usage with GDP per capita are found to be feeble, with the exception of e-administration, however.

Model Development

Fig. 1 explains our model outlined above. Hypotheses are specified formally at the end of this section. The model portrays direct and indirect effects of two multi-item constructs: Education Quality and On-the-Job Training. The data substances for each construct are from a survey led by the WEF as a part of their work on the Global Competitiveness Report 2009–2010 (Lopez-Claros et al. 2010). The survey gathers information on a comprehensive range of variables for which hard data sources are scarce or, frequently, non-existent. Compound consistencies for all concepts that we make

Fig1: The Theoretical Model



from person survey substances are high and are reported in the results section. Truthful data made available by the ITU and the World Bank are also used. Details are given in the measures section below.

First, we are investigating whether upper levels of education quality and on-the-job training are related with ICT use and with upper stages of GDP per capita. The level of national human capital seems to be powerfully related with computer adoption (Caselli & Coleman 2001). Also, "education and training are conclusive in national competitive benefit. They constitute possibly the single utmost long-term leverage point" (Porter 1990). Thus, one feature of our research model appearances for direct relations of these two latent variables with ICT use and GDP per capita.

Second, it has been persuasively contended that the application of ICT offers phenomenal chances for wealth formation and is key to the modernisation of economies—(e.g., Amit & Zott 2001, Baliamoune-Lutz 2003, Chacko 2005, Qureshi 2005). Thus, we evolve multi-item measures of ICT usage for three critical areas: personal ICT use, commercial ICT use, and administration ICT usage. We are interested in the direct relations of ICT usage with GDP per capita as well as the unintended relations of education quality and on-the-job training on GDP per capita through the three Internet usage areas. That is, we examine the superseding role of these three ICT usage areas on the relationship among education quality and on-the-job training and GDP per capita. Stating the aforementioned as official, directional hypotheses are as follows:

H_1: Education quality is definitely related to GDP per capita.

H_2: On-the-job training is definitely related to GDP per capita.

H_3: Personal ICT use is definitely related to GDP per capita.

H_4: Commercial ICT use is definitely related to GDP per capita.

H_5: Administration ICT use is definitely related to GDP per capita.

H_6: Education quality is definitely related to the extent of person ICT use.

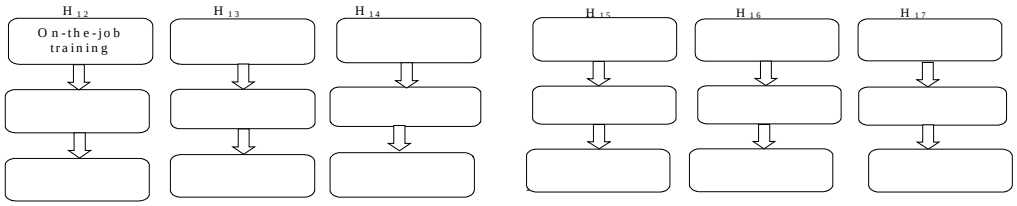
H_7: Education quality is definitely related to the extent of commercial ICT use.

H_8: Education quality is definitely related to the extent of administration ICT use.

H_9: On-the-job training is definitely related to the extent of person ICT use.

H_{10}: On-the-job training is definitely related to the extent of commercial ICT use.

H_{11}: On-the-job training is definitely related to the extent of administration ICT use.



Data was obtained by measures used by the WEF, the Telecommunications Union, and the World Bank for 2010. They comprise mean replies for each of the 112 countries, surveying over 13,000 specialists for the WEF Executive Opinion Survey. The survey items use seven-level response scales. WEF conducts rigorous quality control measures to protect not only "clean data" but also data that reproduce the global standing of the countries. Thus, their data are highly similar across the countries. Factual data for personal usage factors were obtained from the ITU.

Labour economists have contended that measuring education must comprise notions of quality rather than, for example, simply using measures such as spending (Griliches 1997). We take this view here and with our chosen measures of education. Education quality is resulting from the WEF survey items as in tables 1-3.

Table 1 Education Quality Resulting from the WEF Survey Items

Education quality	WEF Survey items	
	1	7
Internet access in schools	Very limited	Extensive; most children have frequent access
The educational system in your country	Does not meet the needs of a competitive economy	Meets the needs of a competitive eeconomy
Management or commercial schools in your country	Limited or poor quality	Among the bestin the world
Math and science education	Lag far behind most other	Is among the best in the

in your country's schools	countries	world
The public (free) schools try	Poor quality	Equal to the best in your coun- the world

On-the-job training items:

On-the-job training		WEF Survey items
	1	7
Specialised research and training services in your country	Not available	Available from world-class local institutions
The general approach of companies, in your country	Invest little in training and employee development	Invest heavily to attract, train and retain employees

Personal ICT usage is derived from the following ITU items:

- Personal computers per 100 inhabitants.
- Total broadband Internet subscribers per 100 inhabitants.
- Internet users per 100 inhabitants.

Table 2 Commercial ICT Usage Items

Commercial ICT use		WEF Survey items
	1	7
Companies use the Internet extensively for buying and selling goods and services and for interaction with customers	Strongly disagree	Strongly agree
Mobile or cellular telephones for your commercial	Not available	Just as accessible and affordable as in the world's most technologically advanced countries
Companies in yours country	Not able to absorb new technology	Aggressive in absorbing new technology

Table 3 Administration ICT Usage Items

Administration ICT use		WEF Survey items
	1	7
Online administration services such as personal tax, car registrations, passport applications, commercial permits and e-procurement	Not obtainable	Extensively obtainable
ICT use by the administration has improved the efficiency of administration services and has facilitated interaction	Strongly disagree	Strongly agree

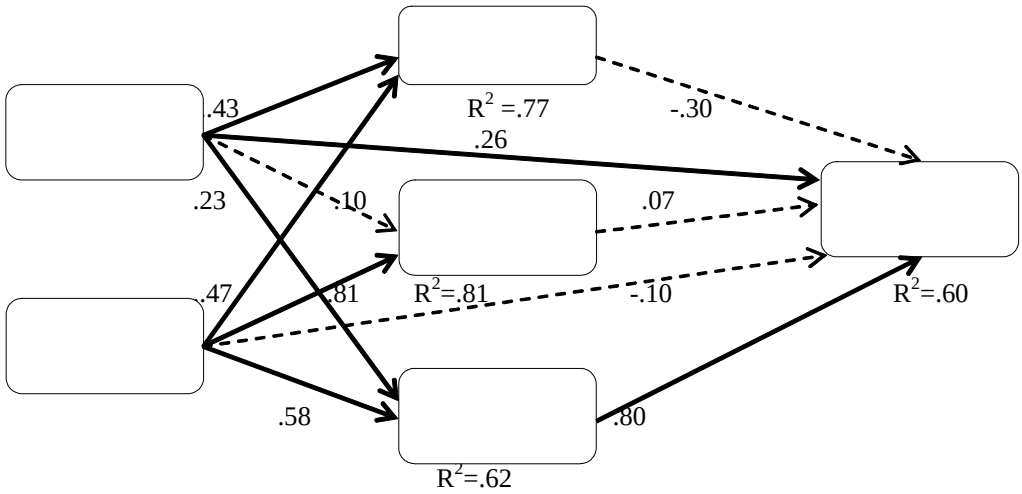
with commercial and civil society		
The attendance of ICT in administration offices in your country	Very rare	Commonplace and pervasive

Results

PLS analysis is performed using SmartPLS (Ringle, Wende & Will 2010). The sample size prevents maximum likelihood mechanical equation modelling, and so PLS is used for exploratory path analysis using the standardised coefficients arrangement as well as bootstrapping with cases of 500 and with 1000 iterations for implication testing. Note that PLS mitigates multicollinearity anxieties extant with Ordinary Least Squares (OLS) regression.

Fig. 2 presents a path analytic diagram of the theoretical model with the statistical analysis results across all 112 countries. The compound consistencies for our concepts (latent variables) given in the preceding section are strong, with all being greater than 0.9. R^2s are also usually strong and are shown on all figures. To highlight the paths consistent with our reinforced hypotheses, the paths, their standardised coefficients, and their significance levels seem in boldface type in each figure. Only the paths that are statistically important and that have standardised path coefficient greater than 0.2 seem in boldface type because that minimum level proposes applied significance (Chin 1998). Paths that are marginally significant statistically or basically are shown with medium-boldface type arrows.

Fig. 2: Model Analysis Results for all 112 Countries with Path Coefficients, and R^2



Looking at Fig. 2, the important relations of education quality are several. Not only is there a direct connotation with GDP per capita, there is also an indirect

connotation with GDP per capita through administration ICT use. Education quality also has a direct connotation with personal ICT use and a marginal connotation with commercial ICT use.

ICT diffusion and adoption vary between developed and developing countries (World Bank 2010). We next explore the differences between developed and developing countries. To do so, we partitioned the

Fig.3: Model Analysis Results for Upper GDP per capita (56) Countries with Path Coefficients, and R^2

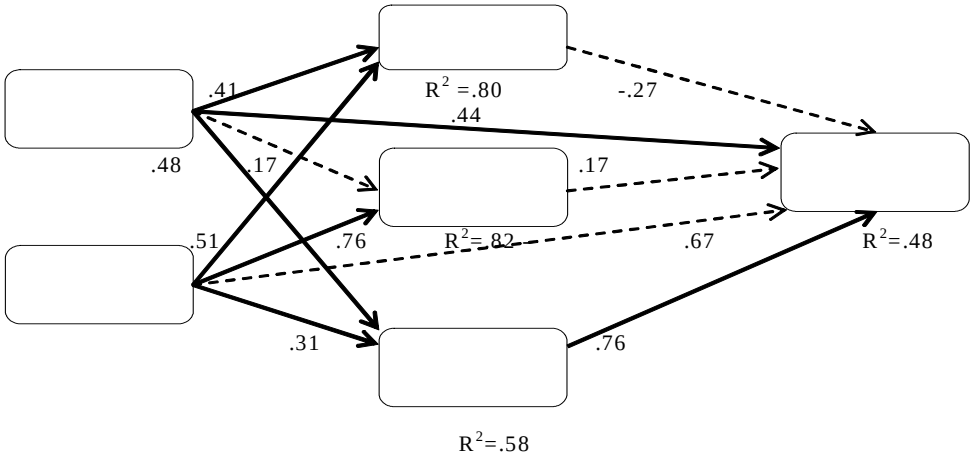
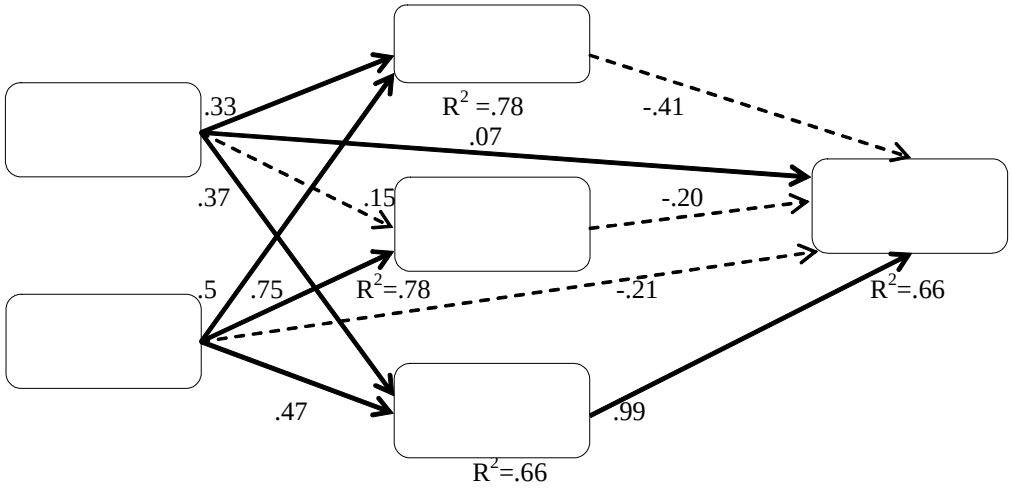


Fig. 4: Model Analysis Results for Lower GDP per capita (56) Countries with Path Coefficients, and R^2



112 countries into two groups based on the median GDP per capita and analysed each group separately. Fig. 3 and Fig. 4 show the results for the upper and lower GDP groups.

Looking at the boldface paths, it is obvious that some significant paths are common among groups: Both education quality and on-the-job training definitely affect all three ICT usage areas, though the path coefficient from education quality to commercial ICT use is comparatively weak. This is a very significant finding as it designates that human resource development through education and training may indeed lead to strong modernisation forces through information technology use across all usage areas and for countries at various phases of economic growth. There is, though, a very stimulating difference among the two groups.

Both education quality and on-the-job training definitely affect all three ICT usage areas.

Discussion & Conclusions

Table 4 summarises the results. It is obvious that the results are justly reliable using all countries and using countries distinctly measured based on upper and lower GDP per capita grouping. Both education quality and on-the-job training appear to be influential catalysts for the modernisation of economies via ICT use by persons, commercial, and administration. This is in conflict with Baliamoune-Lutz (2003) who found that ICT diffusion was not related to education in emerging countries (Pick & Azari 2008). It must be kept in mind that our measure of education explicitly addresses the quality thereof and that our procedures of education, training, and ICT diffusion crossways three areas are more extensive. Further, our analyses include more countries and at a more recent point in time.

This effect is stimulating and may reproduce a reality where richer countries can afford to invest in formal educational systems and their citizens are better talented to join such schooling. Poorer countries, on the other hand, may essentially rely on employers for training. If public education is weak, then commercial enterprises must pick up the slack through on-the-job training to hold their competitiveness. Lastly, observing the R^2s for GDP per capita, it is obvious that the model explains GDP per capita best overall and for lower stages of GDP countries, and next for upper stages of GDP countries. However, the model explains variance in ICT usage across the areas of personal, commercial, and administration quite well and consistently.

Table 4. Summary of Results

Hypothesis	Overall	Upper-GDPs	Lower-GDPs
1	Yes	Yes	No
2	No	No	Yes
3	No	No	No
4	No	Marginal	No
5	Yes	Yes	Yes
6	Yes	Yes	Yes
7	Marginal	Marginal	Marginal
8	Yes	Yes	Yes
9	Yes	Yes	Yes
10	Yes	Yes	Yes
11	Yes	Yes	Yes
12	No	No	No
13	No	Marginal	No
14	Yes	Yes	Yes
15	No	No	No
16	No	Marginal	No
17	Yes	Yes	Yes

Previously, we have addressed the features of our model concerning reinforced hypotheses (model paths), but it is valuable to look at what hypotheses were not supported. Person and commercial ICT uses are not definitely related to GDP per capita in general or for upper or lower levels of GDP per capita countries, though the commercial ICT use to GDP link is marginally important both statistically and almost for upper levels of GDP countries. Though this is somewhat reliable with the argument that "economic and social theory converge to the proposal that ICT dispersal and strengthening of information activities do not lead deterministically to economic development "(Avgerou 1998), it is significant to note that in post- hoc analysis the bivariate correlation coefficients between LnGDPpc and the other PLS-generated latent variable scores range from 0.47 to 0.76 when measured in separation. Each is significant ($p<0.001$).

	BICTU	Edu	GICTU	IICTU	Training
LnGDPpc Pearson Correlation	.626	.568	.755	.473	.564

It is significant to point out several limitations of this research. First, PLS is best suited to exploratory analysis as an introduction to a robust interpretive technique such as maximum likelihood mechanical equation modelling (Garson 2010). Though, our small sample size (112) comparative to the number of model strictures disqualifies a maximum likelihood mechanical equation modelling technique. Therefore, the current investigation should be treated as exploratory. Second, the measures used in this investigation are broad indicators. Nevertheless, they are very valuable in painting a worldwide picture. Though they should not be considered as a sole basis of information on the issues examined here, they positively provide a broad viewpoint that can serve as a direction for supplementary detailed analysis. Third, as this study uses cross-sectional data, it is imprudent to invite firm wise cause-and-effect conclusions.

References

Amit, R., & Zott, C. (2001), "Value Creation in e-commercial" *Strategic Management Journal*, 22(6/7): 493–520.

Avgerou, C. (1998), "How Can IT Enable Economic Growth in Developing Countries?" *Information Technology for Development*, 8(1): 15–28.

Baliamoune-Lutz, M. (2003), "An Analysis of the Determinants and Effects of ICT Diffusion in Developing Countries", *Information Technology for Development,* 10(3): 151–69.

Chacko, J.G. (2005), "Paradise Lost? Reinstating the Human Development Agenda in ICT Policies and Strategies", *Information Technology for Development*, 11(1): 97–99.

Chin, W. (1998), "Issues and Opinion on Structural Equation Modelling", *MIS Quarterly,* 22(1): vii – xvi.

Corea, S. (2007), "Promoting Development through Information Technology Innovation: The IT Artefact, Artfulness, and Articulation", *Information Technology for Development,* 13(1): 49–69.

Garson, D. (2010). "Partial least Squares Regression"—Stat notes. Retrieved February 29, 2010, from http://www2.chass.ncsu.edu/garson/pa765/pls.htm

Griliches, Z. (1997), "Education, Human Capital, and Growth", *Journal of Labour Economics*, 15(1): 330–44.

Lopez-Claros, A., Schwab, K. & Porter, M. (eds.) (2010). The Global Competitiveness Report 2009–2010, Geneva, Palgrave-MacMillan.

Pick, J.B. & Azari, R. (2008), "Global Digital Divide: Influence of Socioeconomic, Administrational, and Accessibility Factors on Information Technology", *Information Technology for Development*, 14(2): 91–115.

Porter, M.E. (1990), The Competitive Advantage of Nations, New York: The Free Press.

Qureshi, S. (2005), "E-administration and IT Policy: Choices for Administration Outreach and Policy Making", *Information Technology for Development*, 11(2): 101–03.

Ringle, C. M., Wende, S. & Will, S. (2010). SmartPLS. Retrieved June 25, 2010, from http://www.smartpls.de.

World Bank. (2010), Global Economic Prospects, Retrieved July 11, 2010, from http://siteresources.worldbank.org/INTGEP2008/Resources/complete-report.pdf

Appendix-A

List of Countries

Algeria
Albania
Angola
Argentina
Armenia
Australia
Austria
Azerbaijan
Bahrain
Bangladesh
Barbados
Belgium
Benin
Bolivia
Bosnia & Herzegovina
Botswana
Brazil
Bulgaria
Burkina Faso
Burundi
Cambodia
Cameroon
Canada
Chad
Chile
China
Colombia
Costa Rica
Guatemala
Guyana
Honduras
Hong Kong
Hungary
Iceland
India
Indonesia
Iran Islamic Republic
Ireland
Italy
Jamaica
Japan
Jordan
Kazakhstan
Kenya
Korea,
Kuwait
Kyrgyz Republic
Latvia
Lesotho Taiwan,
Lithuania
Luxembourg
Macedonia, FYR
Madagascar
Malawi
Malaysia
Mali
Pakistan
Panama
Paraguay
SAR Peru
Philippines
Poland
Portugal
Qatar
Romania
Russian Federation
Serbia and Montenegro
Singapore
Slovak Republic
Slovenia
South Africa
Spain
Rep. Sri Lanka
Suriname
Sweden
Switzerland
China
Tanzania
Thailand
Trinidad and Tobago
Tunisia
Turkey
Uganda
Ukraine

Croatia	Malta	United Arab Emirates
Cyprus	Mauritania	United Kingdom
Czech Republic	Mauritius	United States America
Denmark	Mexico	Uruguay
Dominican	Republic Moldova	Venezuela
Ecuador	Mongolia	Vietnam
Egypt	Morocco	Zambia
El Salvador	Mozambique	Zimbabwe
Estonia	Namibia	
Ethiopia	Nepal	

Appendix-B

First introduced in the 2006–2007 Global Information Technology Readiness (GITR) report, which serves as the technological component of the Global Competitiveness Report published annually by the World Economic Forum, the NRI is defined as follows: "the degree of preparation of a nation or community to participate in and benefit from ICT developments." The NRI was refined further by the Organisation European Administration Affaires. The present index includes nearly 70 quantitative and qualitative variables joint to form sub-indices of network use and enabling or environmental factors.

The Executive Opinion Survey developed jointly by The World Economic Forum for Global Growth and Organisation for Strategy and Competitiveness cover qualitative measures. The survey gathers information on a broad range of variables for which hard data sources are scarce or, frequently, non-existent (Lopez-Claros et al. 2010). For each country, a Partner Organisation is selected to conduct the Executive Opinion Survey among an illustrative sample of commercial and administration leaders in their respective countries. These leaders are selected based upon not only their broad knowledge with the current circumstances in their countries but also their knowledge and experience of the global environment. Over 13,000 answers were received for the 2009–2010 report.

The survey dataset experiences a thorough verification procedure aimed at excluding blatant outlying answers and answers from very small corporations which might have difficulty associating their operating environment to a worldwide standard. Also, potential perceptual bias is mitigated through reliability analyses, which comprises distributional testing and triangulation with related objective measures.

Sample sizes per country are decisively diverse according to the size of the economy. At least 30 answers were conventional per country, with 93% of the countries having 50 or more respondents. The answer rate was 97%. The GITR reports consequences as the mean value of each measure for each country. The overall data is used by frequent organisations for many drives, such as the US Agency for International Development (USAID), which uses it as a guide in endorsing long-term and reasonable growth in countries universal and in monitoring their development.