POLIHEURISITC APPROACH OF CYBERWARFARE BASED ON CYBER POWER INDEX

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Abstract: *This research paper presents a merging way for study the cyberwarfare based on two theoretical approaches. The first one poliheuristic approach proposed by Alex Mintz in study of foreign policy, and the second way is the concept of cyber power index created by Intelligence Unit division of the british journal „The Economist". The cyberwarfare poliheuristic study approach uses the EUI's cyber-power index questionnaire for a qualitative approach based on the evaluation of the decision matrix rates and weights. The presented method aims to become a standard in the field of cyberwarfare and an alternative to the purely rationalist approaches that are currently being invoked in this research field.*

Keywords: decision matrix, foreign policy management style, decision rules

1. INTRODUCTION

The poliheuristic paradigm of foreign policy aims to study the foreign policy motivations and behaviors of a state. For the motivation study, the poliheuristic decision matrix together with the decision-making mechanisms based on "cognitive short-cuts" were used. For the research of behavior are adopted various typologies. In this research, we adopt Clausewitz's idea [1]: cyberwarfare is a behavior by which a state actor continues its foreign policy with cyber offensive means that have the support its main critical cyber infrastructure. (the definition can also be adapted to non-state actors involved in cyber activities, even if they have no foreign policy). Through the concept of national critical cyber infrastructure, we consider the collection of computer-servers, computer-clients and physical information systems (cables, fiber optics, radio antennas) connected in a systemic ensemble [2]. These components of critical cyber infrastructure provide the modern way to a knowledge-based society but can also constitute the projection elements of the power of a state or non-state actor in the international relations arena. To measure this cyber power of a state, the Intelligence Unit division of the british journal „The Economist" (EUI) [3] proposed a cyber power rating questionnaire found in the appendix of this article. The cyber power, defined in EUI as the way to manifest the foreign policy of an actor in the online space, has five dimensions: Legal and Regulatory Framework, Economic and Social Context, Technology Infrastructure, Industry Application, Background Indicators. These dimensions of critical cyber power are the elements that are either mathematical evaluations or psychological projections based on "cognitive short-cuts" defining the motivation of an actor. For the manifestation of cyber power as a behavior, we will use the typology proposed by Craig B. Greathouse [1]:

1. Action of Cyber Espionage and Cyber Crime - is the way in which state or non-state actors use organized crime methods with the collection of any type of information about a critical infrastructure as target; 2. Action of Denial of Service - these are the attacks on critical cyber infrastructure that perform the "denial of service" effect between computer-servers and computer-clients; 3. Action of Focused Cyber Attack - these are the types of attacks to critical cyber infrastructure that allow it to recover quickly through some mechanisms such as data recovery; 4. Action of Massive Cyber Assault - refers to attacks to critical cyber infrastructure that generate great damage and its inability to recover shortly and data recovery is not allowed. Because all cyberwarfare specific elements are dealt with in the field of poliheuristic paradigm of foreign policy, we will further detail the elements of this paradigm.

The paternity of the poliheuristic paradigm belongs to Israeli political scientist Alex Mintz [4]. The central concept of this paradigm is that the foreign policy decision of a leader, decision-maker or decision-making group - depending on the state management mode in foreign policy - is carried out in two stages (two-stage decision process). As a result of the first stage of the decision, the author proposed the use of cognitive decision paradigms in psychology, and in the second stage of the decision the paradigm of rational choice is used [4]. We can certainly say that the poliheuristic paradigm is a new generational synthesis paradigm, such as the new approach in Operational Code Analysis [5] or economical theories based on bounded rationality. For the first cognitive decision-making stage of the decision-maker (leader, decision-making group or decision-making groups), the author believes that making a judgment is based on bias. This bias is a result of cognitive mechanisms of "cognitive short-cuts" heuristics at the base of the human brain [4]. Alex Mintz proposed in his paper the following biases mechanisms based on "heuristics cognitive short-cuts" [4]: 1. "Focusing on short-term benefits rather than longer-term problems"; 2. "Preference over preference"; 3. "Locking on one alternative"; 4. "Wishful thinking"; 5. "Post-hoc rationalization"; 6. "Relying on the past"; 7. "Focusing on a narrow range of policy options rather than on a wide range of options"; 8. "Groupthink"; 9. "Overconfidence; over-estimating one's capabilities and underestimating rival's capabilities "; 10. "Ignoring critical information; denial and avoidance "; 11. "Focusing on only part of the decision problem"; 12. "Turf battles leading to suboptimal decisions"; 13. "Lack of tracking and auditing of prior decisions and plans"; 14. "Poliheuristic bias"; 15. "Shooting from the hip"; 16. "lthink"; 17. "Group polarization effect".

The paradigm is called poliheuristic because in the analysis of a certain foreign policy decision, there are several models of "cognitive short-cuts heuristics" in combination. After identifying the bias patterns used by the political decision-maker, it will be taken into the first stage of the decision to construct its decision matrix by establishing the types of actions to be followed, namely the dimensions of the objectives-results, which it aims to touch them.

In the second step of the decision-making process, the rational choice paradigm will be used to decide a sequence of actions based on constraints or other preferences of the decision-maker related to gains or losses.

In their research on Danish intervention in the Libyan crisis in 2011, Dennis Hansen, Spetim Ibisi, Ramne Pranaityte concluded that the poliheuristic paradigm is characterized by [6]:

1. Decision-makers based on poliheuristic biases that use rapid decisions focusing on critical dimensions of results and rejecting actions that provide unacceptable results.

2. For the evaluation of the remaining actions the analysis for the critical dimensions will focus on the rational choice paradigm that aims at maximizing profits, minimizing losses and risks.

That is why the poliheuristic paradigm has a bounded rationality that cannot encompass the whole spectrum of options of the decision maker. Several variants of specific prejudices for certain actions of the decision matrix can lead to different rational options such as maximizing profits vs minimizing risk or minimizing losses versus minimizing risk.

All three Danish authors consider their research based on the poliheuristic paradigm has the following features [6]: "The compromise of the two schools of thought provides a reliable tool for the analysis, and has empirically provided the field of FPA (foreign policy analysis) with new insights into the decision making process. The first step focuses on identifying when the decision makers have utilized cognitive shortcuts to make the decision process simpler and more comprehensible. The second step relies on a rational choice on how much Denmark is *capable* of engaging in the international contribution to the humanitarian intervention in Libya".

In addition to the paradigm of synthesis of a new generation in which the political actor decides not to focus only on the outcome as in the case of the rational paradigm, Alex Mintz believes that in his proposed theory the decision is influenced by the domestic political process [4]. The same author points out that the following features of the decision-making process: "Political leaders virtually always take into account (explicitly or implicitly) domestic political factors and consequences while making decisions. The noncompensatory principle of poliheuristic theory suggests that in a choice situation, if a certain alternative is unacceptable politically" [4]. *By the non-compensatory principle, the author suggested that it is important to establish a hierarchy between the dimensions of the objective-result so that the decision maker aims to simplify the decision-making process*. One of the most important dimensions of the decision matrix is the decision-maker's internal political system, which is considered by a number of authors to be the supreme constraint in the poliheuristic approach [4]. Here's how to construct the poliheuristic decision matrix that characterizes the process in two steps.

2. METHODOLOGY

Poliheuristic decision matrix - operation with this analytical tool is characterized by two stages. The first stage determines the composition of the decision matrix and in the second stage the decision making rules are established.

2.1. The first element is to establish the model of management in foreign policy. There is a multitude of political psychology studies such as those focused only on the leader [7], leader-group-decision-making groups [8]. Once the type of decision-maker and his / her management in foreign policy has been established, the process of building the decision-maker matrix of the decisional actor based on his / her experience will be pursued. With the help of the poliheuristic matrix of decision-making, Alex Mintz believes that we can reverse the way how the decision-maker has cognitively implemented information processing from his past political experiences [4]. Thus, the structure of a decision-making matrix is presented in Figure 1, consisting of lines explicitly expressed on the critical dimensions of the objectives-results $o_1, \dots , o_m$,, respectively on the actions that make up the columns $a_1, \dots , a_n$.

	a_1	...	a_n	w
o_1	r_{11}	...	r_{1n}	w_1
...	...	...	...	...
o_m	r_{m1}	...	r_{mn}	w_m
Final Choice				

FIG.1. Poliheuristic decision matrix to a state decision-maker.

From the analysis of the foreign policy management process to identifying foreign policy actions, a decision criterion is needed. From our bibliographic analysis, the most appropriate criterion for the cyber warfare poliheuristic study is the typology of Craig B. Greathouse, to which we add the action of non-involvement or neutrality "do nothing".
Actions – the actions of decision matrix are the following: Do nothing, Action of Cyber Espionage and Cyber Crime, Action of Denial of Service, Action of Focused Cyber Attack, Action of Massive Cyber Assault.

Dimensions - to the management criterion, another important element is the identification of the critical dimensions of the objectives and the results. In this research, we consider the five dimensions of the cyber power index in the Appendix: Legal and Regulatory Framework, Economic and Social Context, Technology Infrastructure, Industry Application, Background Indicators.

Implications - are explanations of the consequences an alternative may have on one or more critical dimensions (e.g.: may be explanations of synthesis summaries of items in Appendix).

Ratings - are numerical values attributed to the particular action (mean) for a specific dimension (scope); the implications that explain the goal-mean relationship that can be evaluated from -10 (very bad) to +10 (very good); critical dimensions' goal having positive rates.

Weights - are part of the management criterion in foreign policy and indicate to the analyst the level of importance that the decision maker gives to a dimension of the objectives or results of the poliheuristic decisional matrix. It has values of 0 and 10.

2.2. Determining the decision rules - if in the first stage the negative rates were associated with the dimensions of the decision matrix and a first evaluation of the implications was made in this way, we can establish the critical dimensions for the decider after the positive value of the rates. After excluding the uncritical dimensions in the decision matrix we move from the cognitive to the rational stage in which we determine the decision rules following the models below [9] for apposition of *the non-compensatory principle*:

1. Weak dominance – is an order relation noted as $a_k \geq a_{k+i}$ if and only if

$$r_{kj} \geq r_{(k+i)j}, \forall k, i = \overline{1,n}; \forall j = \overline{1,m}. \tag{1}$$

2. Strong dominance – is an order relation noted as $a_k > a_{k+i}$ if and only if for some k

$$r_{kj} \geq r_{(k+i)j} \text{ and for the remaining k } r_{kj} > r_{(k+i)j}, k, i = \overline{1,n}; \forall j = \overline{1,m} \tag{2}$$

3. Maximin - is an order relation noted as $a_k \geq a_{k+i}$ is and only if

$$\min(r_{kj}) \geq min(r_{(k+i)j}), \forall k, i = \overline{1,n}; \forall j = \overline{1,m}. \tag{3}$$

4. Leximin - is an order relation noted as $a_k > a_{k+i}$ if and only if

$$\min(r_{k(j+p)}) > \min(r_{(k+i)(j+p)}), \forall k, i = \overline{1, n}; j + p \leq m, \forall j, p = \overline{1, m} \text{ and for} \quad (4)$$

the remaining k, $\min(r_{kl}) = \min(r_{(k+i)l}), \forall k, i = \overline{1, n}; \forall l, p = \overline{1, m}, l < p.$

5.Maximax and the optimism–pessimism rule – Naturally, α is assumed to be fixed throughout the evaluation of all alternatives a_i. Is an order relation noted as $a_k > a_{k+i}$, if and only if the following relation is satisfied:

$$\alpha \cdot max(r_{kj}) + (1 - \alpha) \cdot min(r_{kj}) \quad (5)$$
$$> \alpha \cdot max(r_{(k+i)j}) + (1 - \alpha) \cdot min(r_{(k+i)j}), \forall k, i = \overline{1, n}; \forall j = \overline{1, m}.$$

6.$\alpha \cdot max(r_{kj}) + (1 - \alpha) \cdot min(r_{kj}) >$
$\alpha \cdot max(r_{(k+i)j}) + (1 - \alpha) \cdot min(r_{(k+i)j}), \forall k, i = \overline{1, n}; \forall j = \overline{1, m}$.Minimax regret - is an order relation noted as $a_k > a_{k+i}$ if and only if the following relation is satisfied:

$$\max\{(r_{kj} - \max(r_{kj}))\} > \max\{(r_{(k+i)j} - \max(r_{(k+i)j}))\}, \quad (6)$$

$$\forall k, i = \overline{1, n}; \forall j, p = \overline{1, m}$$

7.$max\left\{\left(r_{kj} - max(r_{kj})\right)\right\} > max\left\{\left(r_{(k+i)j} - max(r_{(k+i)j})\right)\right\}, \forall k, i = \overline{1, n}; \forall j = \overline{1, m}$The principle of insufficient reason – is an order relation noted as $a_k > a_{k+i}$, if and only if the following relations are satisfied:

$$w_j = \frac{1}{n}\sum_{i=1}^{n} r_{ij}, \text{ and } w_j > w_{j+p}, \forall k, i = \overline{1, n}; j + p \leq m, \forall j, p = \overline{1, m} \quad (7)$$

3. RESULTS

A number of case studies will be undertaken to build the decision-making matrix of a state actor that will analyze the types of behavior that it can adopt. Possible cyberwarfare behaviors are: Do not, Action of Cyber Crime, Action of Denial of Service, Action of Focused Cyber Attack, Action of Massive Cyber Assault. For each action, we analyze how to conduct leadership, group leadership, or groups. Then we identify the critical dimensions of the decision matrix. We suppose that in this study all five dimensions of the cyber power index are critical. For each case study, the cyber power index post-event questionnaire will be applied, because the consequences of past events are based on a "cognitive short-cuts" decision. For multiple items in the questionnaire, a five-step scale is used from 0 to 4. For items that do not have defined scales, similar scales will be built. For each rate in the table from Fig. 2, an average rate will be calculated as follows (8):

$$r_{ij} = \left[\frac{\sum_{i=1}^{N_j}(1 + s_{ij})}{N_j} \cdot 2\right] \quad (8)$$

Where N_j is the number of items of each dimension in the cyber power index questionnaire, and s_{ij} is the score of an item i of the size j and has values from 0 to 4, which are found in the case study. Operator [] represents the integer of the average value multiplied by two to obtain integer values between 0 and 10.

Once we have established the values of rates and weights based on expression (8), the rules of Weak dominance (1), Strong dominance (2), Maximin (3), Leximin (4), Maximax and the optimism-pessimism rule (5), Minimax regret (6), the principle of insufficient reason (7) will determine the order of the actions from the most preferred to the less preferred by calculating the final choice based on relationships that defines decision rules.

	Do nothing	Action of Cyber Espionage and Cyber Crime	Action of Denial of Service	Action of Focused Cyber Attack	Action of Massive Cyber Assault	
Legal and Regulatory Framework	r_{11}	r_{12}	r_{13}	r_{14}	r_{15}	w_1
Economic and Social Context	r_{21}	r_{22}	r_{23}	r_{24}	r_{25}	w_2
Technology Infrastructure	r_{31}	r_{32}	r_{33}	r_{34}	r_{35}	w_3
Industry Application	r_{41}	r_{42}	r_{43}	r_{44}	r_{45}	w_4
Background Indicators	r_{51}	r_{52}	r_{53}	r_{54}	r_{55}	w_5
Final Choice						

FIG.2. Poliheuristic decision matrix for cyberwarfare actions.

4. CONCLUSIONS AND FUTURE WORKS

This research paper proofed a merging way for study the cyberwarfare based on two theoretical approaches. The first one poliheuristic approach proposed by Alex Mintz in study of foreign policy, and the second way is the concept of cyber power index created by Intelligence Unit division of the british journal „The Economist".

The cyberwarfare poliheuristic study approach uses the EUI's cyber-power index questionnaire for a qualitative approach based on the evaluation of the decision matrix rates and weights. The presented method aims to become a standard in the field of cyberwarfare and an alternative to the purely rationalist approaches that are currently being invoked in this research field. Also in the future researches this method will be integrated with image indicators based on verbs into the context system with quantitative methods such as game theory, agent-based modeling, and qualitative predictive methods such as Lockwood Analytical Method for Prediction and will become a standard for cyber and cyberwarfare intelligence studies.

There is a procedure for implementing bounded rationality decision, which will endeavor to enrich itself in the future with research based on cognitive consistency. The presented model does not address the analysis of the cognitive consistency specific to the poliheuristic paradigm that will be dealt with in a future research as well as the introduction of the concept of learning in the cyberwarfare process.

APPENDIX: CYBER POWER INDEX QUESTIONNAIRE AFTER EUI [3]

1.Legal and Regulatory Framework

1.01. "National cyber plan - This indicator measures whether there is a national cyber plan with targets and deadlines. The scoring for this indicator is as follows: 0 = No; 1 = No, but plan is being developed; 2 = Yes, but plan is vague or is poorly enforced; 3 = Yes, but plan is not

comprehensive or has a few shortcomings in implementation; 4 = Yes, plan is comprehensive and has specific targets and deadlines. (Source: Economist Intelligence Unit, Year = 2011) "

1.02. "Public/private partnerships - This indicator measures whether the government engages in public/private partnerships (PPPs). The scoring for this indicator is as follows: 0 = Cyber-related PPPs do not exist; 1 = Government makes limited efforts to partner with private sector; 2 = Active, but uneven efforts; 3 = Above-average efforts; 4 = Strong efforts. (Source: Economist Intelligence Unit, Year = 2011)"

1.03. "Cyber enforcement authority - This indicator measures whether there is a central cyber enforcement authority. The scoring for this indicator is as follows: 0 = No central enforcement authority or collaboration across agencies; 1 = No central enforcement exists, but there is minimal collaboration across agencies; 2 = No central enforcement exists, but there is moderate collaboration across agencies; 3 = Central agency exists with shortcomings in enforcement; 4 = Central enforcement agency exists with evidence of strong enforcement. (Source: Economist Intelligence Unit, Year = 2011)"

1.04. "Cybersecurity laws - This indicator measures whether the country passed national cybersecurity laws, such as data privacy and computer-misuse laws. The scoring for this indicator is as follows: 0 = No cybersecurity laws exist; 1= A few laws exist, but are not enforced; 2 = A few laws exist, with moderate enforcement; 3 = Several laws exist and are adequately enforced; 4 = Laws cover all main areas of cybersecurity and are strictly enforced. (Source: Economist Intelligence Unit, Year = 2011)"

1.05. "Cyber crime response - This indicator measures whether the country has a CERT security response team in place and actively responds to cyber crime. The scoring for this indicator is as follows: 0 = No; 1 = Minimal or limited response; 2 = Uneven response; 3 = Above-average response; 4 = Strong response. (Source: Economist Intelligence Unit, Year = 2011)"

1.6. "International cybersecurity commitments - This indicator measures whether a country is a signatory to an international commitment on cybersecurity, with particular consideration to the Convention on Cybercrime, also known as the Budapest Convention on Cybercrime. The scoring for this indicator is as follows: 0 = No; 1 = Acceding; 2 = Signatory; 3 = Ratified; 4 = In force. (Source: Economist Intelligence Unit, Year = 2011)"

1.07. "Cybersecurity plan - This indicator measures whether the country has a cybersecurity plan with explicit targets. The scoring for this indicator is as follows: 0 = No; 1 = No, but plan is being developed; 2 = Yes, but plan is vague; 3 = Yes, but plan is not comprehensive; 4 = Yes, plan is comprehensive and has specific targets and deadlines. (Source: Economist Intelligence Unit, Year = 2011)"

1.08. "Cyber censorship - The scoring for this indicator is as follows: 2 = Free (0–11 points); 1 = Partly free (12–23 points); 0 = Not free (24–35 points). (Source: Freedom House, Freedom on the Net 2011, Year = 2011)"

1.09. "Political efficacy - A composite score measured on a scale of 0–100, which measures effectiveness of policy formulation; quality of bureaucracy; excessive bureaucracy/red tape; vested interests/cronyism; corruption; accountability of public officials; and human rights. (Source: Economist Intelligence Unit Risk Briefing, Year = 2010)"

1.10. "Intellectual property protection - A measure of the strength of intellectual property protection measured on a scale of 0–4, where 0=best. (Source: Economist Intelligence Unit Risk Briefing, Year = 2010)"

2. Economic and Social Context

2.01. "Tertiary student enrollment as a percentage of total enrollment - The percentage of the 18–22 age group, who are enrolled full-time in tertiary education. (Source: UN Educational, Scientific and Cultural Organization, Year = Latest year available, between 2006 and 2010, unless otherwise indicated in the model)"

2.02. "Expected years of education - The total number of years of schooling (primary to tertiary) that a child of a certain age can expect to receive in the future, assuming that the probability of his or her being enrolled in school at any particular age is equal to the current enrollment ratio for that age. (Source: UN Educational, Scientific and Cultural Organization, Year = Between 2008 and 2009, unless otherwise indicated in the model)"

2.03. "Labor productivity growth - Efficiency of labor, measured in terms of output per worker (real GDP per person employed). This indicator is measured as the percentage change between 2009 and 2010. (Source: Economist Intelligence Unit, Year = 2010)"

2.04. "Researchers in research and development per million people - Researchers in R&D are professionals engaged in the conception or creation of new knowledge, products, processes, methods, or systems, and in the management of the projects concerned. Postgraduate doctoral students (ISCED97 level 6) engaged in R&D are included. (Sources: UN Educational, Scientific and Cultural Organization, Year = Latest year available, between 2006 and 2008, unless otherwise indicated in the model)"

2.05. "Science and Engineering degrees as a percentage of total degrees awarded - The OECD definition of science degrees includes: life sciences; physical sciences; mathematics and statistics; and computing. The OECD definition of engineering degrees includes: engineering and engineering trades; manufacturing and processing; and architecture and building. (Source: Organization for Economic Co-operation and Development; UN Educational, Scientific and Cultural Organization; National Science Foundation; Economist Intelligence Unit, Year = Latest year available, between 2006 and 2010)"

2.06. "English literacy - The scoring for this indicator is as follows: 0 = Very low proficiency; 1 = Low proficiency; 2 = Moderate proficiency; 3 = High proficiency; 4 = Very high proficiency. (Source: Education First; Economist Intelligence Unit, Year = 2011)"

2.07. "Information and communication technology exports as a percentage of total exports - ICT exports include telecommunication, audio and video, computer-related equipment, and electronic components, among other ICT goods. Software is excluded. (Source: UN Comtrade, Year = 2009)"

2.08. "Information and communication technology imports as a percentage of total imports - ICT imports include telecommunication; audio and video; computer-related equipment; and electronic components, among other ICT goods. Software is excluded. (Source: UN Comtrade, Year = 2009)"

2.09. "Openness to trade - This indicator is measured on a scale of 0–5, where 5=best, and represents for trade as a percentage of GDP. (Source: Economist Intelligence Unit Business Environment Rankings, Year = 2010)"

2.10. "Research and development expenditure as a percentage of gross domestic product - R&D expenditure includes current and capital expenditure on creative, systematic activity that increases the country's stock of knowledge. (Source: UN Educational, Scientific and Cultural Organization, Year = Latest year available, between 2006 and 2008, unless otherwise indicated in the model)"

2.11. "Domestic patent filings per million people - A patent filing is defined as the procedure for requesting IP protection at an IP office. The resident filing refers to an application filed with the Office of, or acting for, the State, in which the first-named applicant in the application concerned has residence. (Source: World Intellectual Property Organization, Year = 2009, unless otherwise indicated in the model)"

2.12. "Private equity and venture capital as a percentage of gross domestic product - Private equity is defined as securities that are not listed on a public exchange and is taken as a percentage of gross domestic capital.

Venture capital is considered a sub-set of private equity. (Source: Organization for Economic Co-operation and Development; National Venture Capital Associations; Economist Intelligence Unit, Year = 2010, unless otherwise indicated in the model)"

3.Technology Infrastructure

3.01. "Internet penetration - This indicator measures Internet users per 100people. It also includes subscribers who pay for Internet access (dial-up, leased line, and fixed broadband) and people with access to the worldwide computer network without paying directly, either as the member of a household, or from work or school. (Source: International Telecommunications Union; Economist Intelligence Unit, Year = 2008)"

3.02. "Mobile cellular penetration - This indicator measures mobile cellular subscriptions per 100 people. It also includes the number of subscriptions to a public mobile telephone service using cellular technology, which provides access to the Public Switched Telephone Network.

Post-paid and prepaid subscriptions are included. (Source: Economist Intelligence Unit Technology Indicators, Year = 2008)"

3.03. "Wi-Fi hotspots per million people - This indicator measures the penetration of wireless hotspots, derived from JiWire's database of 636,927 free and paid Wi-Fi locations in 142 countries. (Sources: JiWire, Year = 2011)"

3.04. "Social media penetration - This indicator measures social media users as a percentage of Internet users. (Source: comScore; Economist Intelligence Unit, Year = 2010)"

3.05. "Fixed broadband subscriber lines per 100 inhabitants - Subscriber lines with a transmission speed greater than 128 Kbps per 100 people. Subscriber lines include primary rate interface (PRI) ISDN connections; xDSL connections; cable modem and cable telephony connections; and high-speed fixed wireless connections. (Sources: Economist Intelligence Unit Technology Indicators, Year = 2010 data, unless otherwise indicated in the Global Dynamism Index)"

3.06. "International Internet bandwidth - This indicator is defined as the capacity of backbone operators to carry Internet traffic. (Source: International Telecommunication Union and TeleGeography, Year = 2009)"

3.07. "Information technology spending as a percentage of gross domestic product - This indicator measures total IT spending on packaged software, hardware, and IT services as a percentage of gross domestic product. (Source: Economist Intelligence Unit Technology Indicators, Year = 2010)"

3.08. "Mobile phone tariffs - This indicator measures average per-minute cost of various mobile cellular calls, and is used as a measure of ICT affordability. Tariffs are expressed in international dollars, adjusted for purchasing power parity. (Source: , World Economic Forum; International Telecommunications Union, Year = 2008)"

3.09. "Broadband Internet tariffs - This indicator measures the residential monthly fee of fixed broadband tariffs and is used as a measure of ICT affordability. Tariffs are expressed in international dollars, adjusted for purchasing power parity. (Source: World Economic Forum; International Telecommunications Union, Year = 2008)"

3.10. "Secure servers - This indicator measures the number of servers using encryption technology for Internet transactions. (Source: Netcraft, Year = Latest available year, 2009 or 2010)"

4.Industry Application

4.01. "Smart grids - The scoring for this indicator is as follows: 0 = Smart grids do not exist within the country; 1 = Plans for grid modernization are underway; 2 = Smart grids are moderately, but unevenly, developed; 3 = Smart grids are well-developed; 4 = Smart grids are highly advanced and are widely deployed geographically. (Source: Economist Intelligence Unit, Year = 2011)"

4.02. "E-Health - E-Health initiatives include the development of electronic medical records, tele-medicine provision, and mobile health delivery. The scoring for this indicator is as follows: 0 = E-Health technology does not exist within the country;
1 = Minimal e-Health infrastructure exists; 2 = Moderately deployed, yet unevenly integrated across common avenues; 3 = Deployed across most common avenues; 4 = Well-developed and integrated across all common avenues. (Source: Economist Intelligence Unit , Year = 2011)"

4.03. "Businesses placing orders via the Internet - This indicator is measured as the percentage of business Internet users. The scoring for this indicator is as follows: 0 = 0–9%; 1 = 10–24%; 2 = 25–39%; 3 = 40–54%; 4 = 55%+. (Source: UN Conference on Trade and Development; Organization for Economic Co-operation and Development; Economic Intelligence Unit, Year = Latest year available, between 2006 and 2010)"

4.04. "Individuals placing orders via the Internet - This indicator is measured as the percentage of Internet users. The scoring for this indicator is as follows: 0 = 0–19%; 1 = 20–39%; 2 = 40–59%; 3 = 60–79%; 4 = 80%+. (Source: UN Conference on Trade and Development; Organization for Economic Co-operation and Development; Economic Intelligence Unit, Year = Latest year available, between 2007 and 2010)"

4.05. "Individual use of Internet banking - This indicator is measured as the percentage of Internet users. The scoring for this indicator is as follows: 0 = 0–19%; 1 = 20–39%; 2 = 40–59%; 3 = 60–79%; 4 = 80%+. (Source: UN Conference on Trade and Development; Organization for Economic Co-operation and Development; Economic Intelligence Unit, Year = Latest year available, between 2007 and 2010)"

4.06. "Intelligent transportation – Intelligent transportation systems include arrange of measures, from simple GPS systems to advanced sensor technology, leading to inventions such as electronic tolls; variable speed limits; dynamic traffic lights; and advanced notification and tracking systems. The scoring for this indicator is as follows: 0 = Intelligent transportation systems do not exist within the country;1 = Plans are underway or minimal intelligent transportation systems exist; 2 = Moderately deployed, yet unevenly integrated across common avenues; 3 = Deployed across most common avenues; 4=Well-developed, and integrated across all common avenues. (Source: Economist Intelligence Unit, Year = 2011)"

4.07. "E-Government - This indicator measures the quality, scope, and utility of online services. It is measured on a scale of 0–1, where 0=low provision of online services and 1=high provision of online services. (Source: UN Online Services Index, Year = 2010)"

5.Background Indicators

5.01. "Real gross domestic product, US$atPPP - This indicator measures real gross domestic product at purchasing power parity, divided by the population. (Source: Economist Intelligence Unit Country data, Year = 2010)"

5.02. "Real gross domestic product growth - Percentage change of gross domestic product over 3 years, from 2007 to 2010. The underlying gross domestic product data are calculated at constant market prices, rebased to 2005 constant prices and translated into US$ using the LCU: $ exchange rate in 2005. (Source: Economist Intelligence Unit Country data, Year = 2010)"

5.03. "Human development index - UN composite index that measures development progress by combining indicators of life expectancy, educational attainment and income. This indicator is measured on a scale of 0 to 1, where 0=low human development and 1=very high human development. (Source: UN, Year = 2010)"

5.04. "Gini coefficient - This indicator assesses the level of inequality and is measured on a scale of 0 to 100, where 100=perfect equality. (Source: World Bank, Year = Latest year available, 2007 or 2008)"

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