

Infranomics: A Discipline-of-Disciplines for the XXIst Century

October 27, 2011

Dr. Adrian Gheorghe, Bucharest

Outline

- Infranomics: definition
- Metasystem
- The basic disciplines
- Tangibles and Intangibles
- M&S in light of Infranomics

Infranomics

- **Infranomics**

- infrastructure (supporting vital societal technical functions) and
- nomics (after Gr. νόμος nomos, set of rules)

*The discipline-of-disciplines studying the
Metasystem*

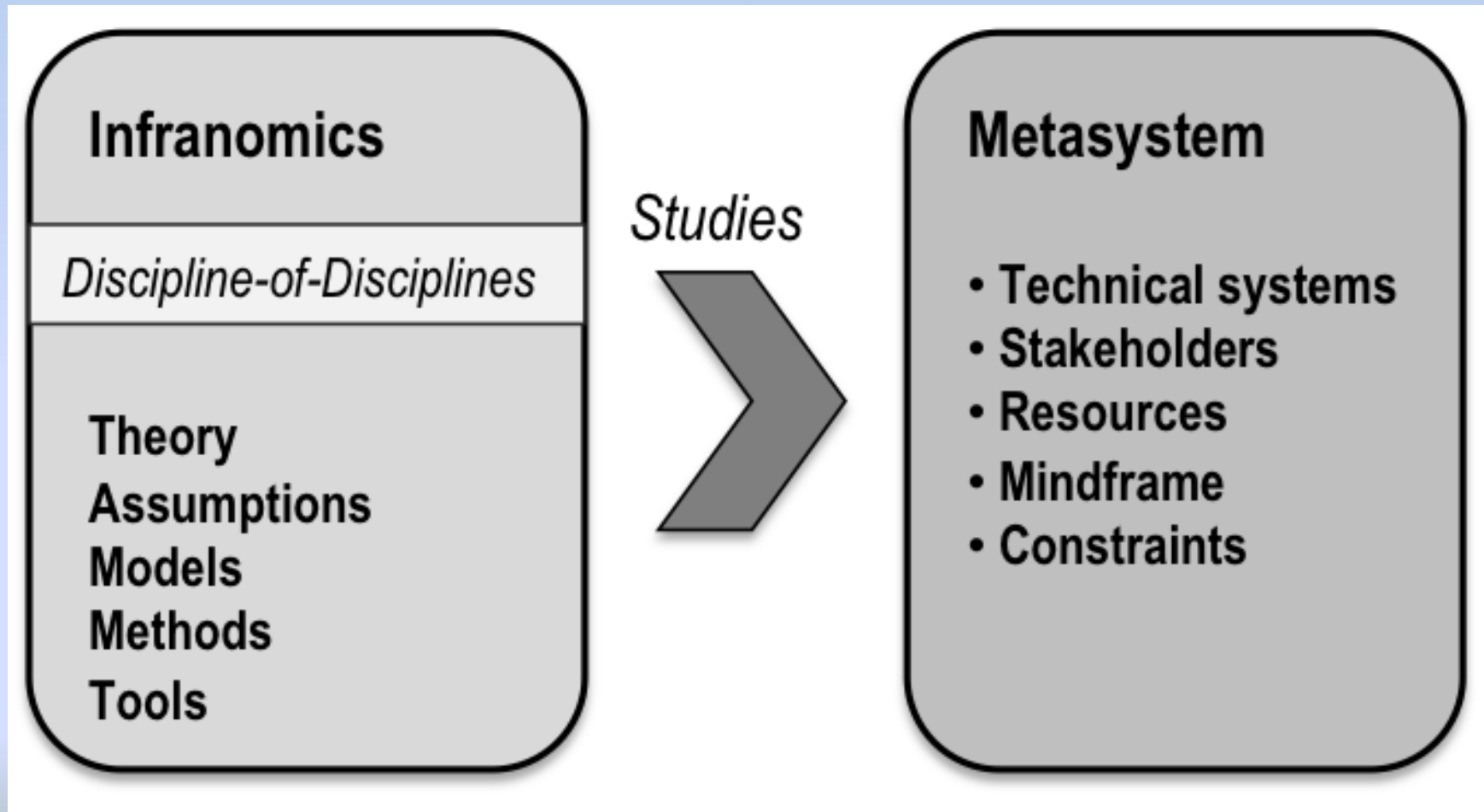
Why?

- Need for:
 - i) systematic approach to the understanding of all the interrelated aspects that constitute the critical infrastructure topic;
 - ii) consideration of all tangibles and intangibles aspects, and all the concurrent concordance-discordance facets;
 - iii) rigorous structuring of the decision making matter in consideration of all.

From Infrastructures to Metasystem

- Infrastructures
 - *Evolving*
 - New ones constructed upon older ones
 - *Multiplicity of actors*
 - No Master
 - *Getting smarter and more interconnected*
- Emergence of the **Metasystem**
 - *Qualitative leap forward*
 - *From underlying resource to vital core*

Metasystem



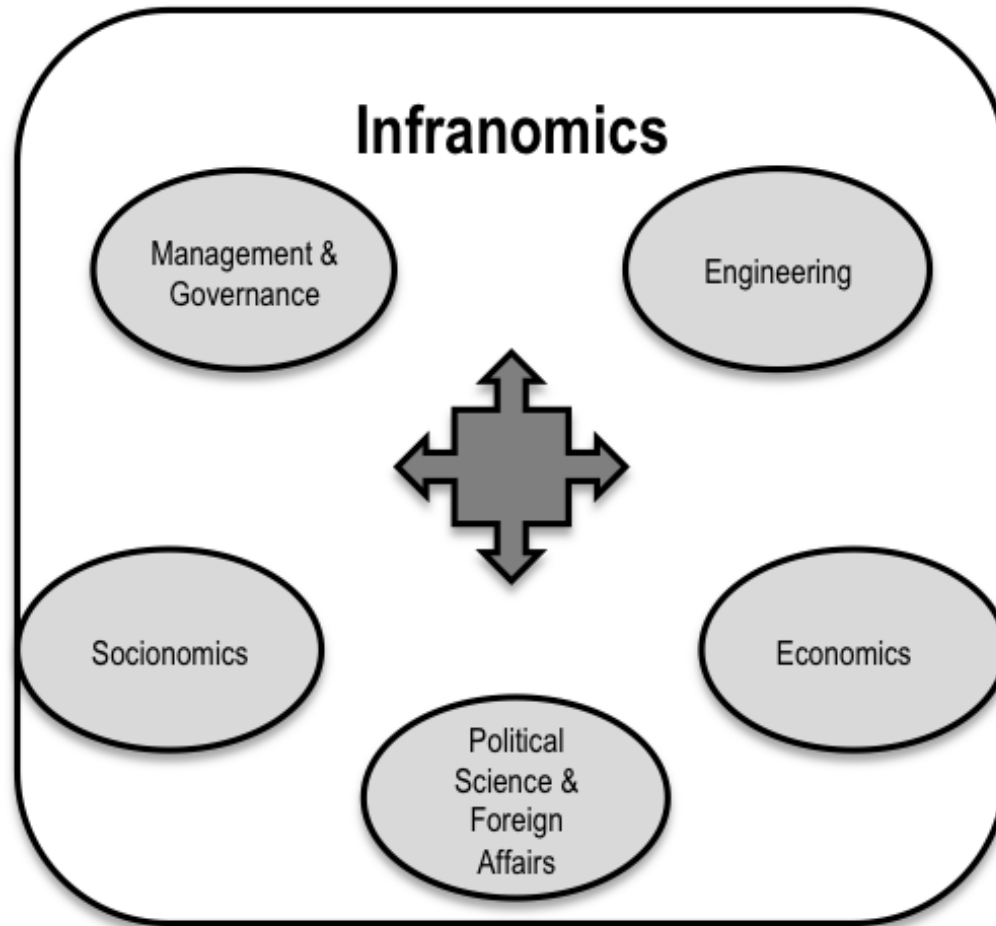
Metasystem /2

- ***Technical components***
 - from the hardware, to the information, command and control parts
- ***Stakeholders***
 - operators, authorities, suppliers, end users, society at large
- ***Resources***
 - monetary, natural, human, technical, information
- ***Mindframe***
 - mentality, mood, cultural traits, etc.
- ***Constraint set***
 - legal context, standards, international rules, etc.

Infranomics revisited

- Body of disciplines supporting the analysis and decision-making regarding the Metasystem
 - *Set of theories, assumptions, models, methods, and associated scientific and technical tools*
 - *Conception, design, development, implementation, operation, administration, maintenance, service supply, and resilience of the Metasystem*

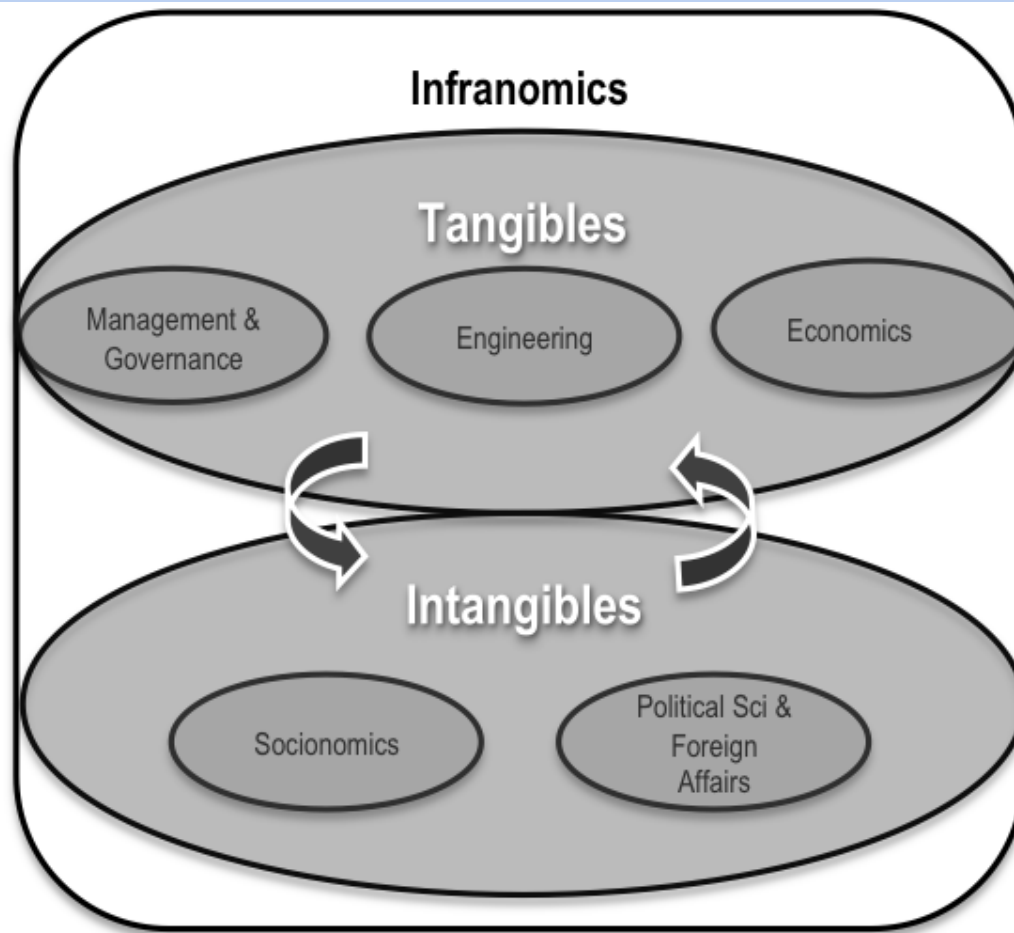
Basic disciplines



Overarching aim

- Infranomics should integrate all relevant disciplines:
 - engineering,
 - economic, political and social sciences,
 - inter-relationships among infrastructures and stakeholders, in a multi-national, multi-jurisdictional context

Tangibles & Intangibles



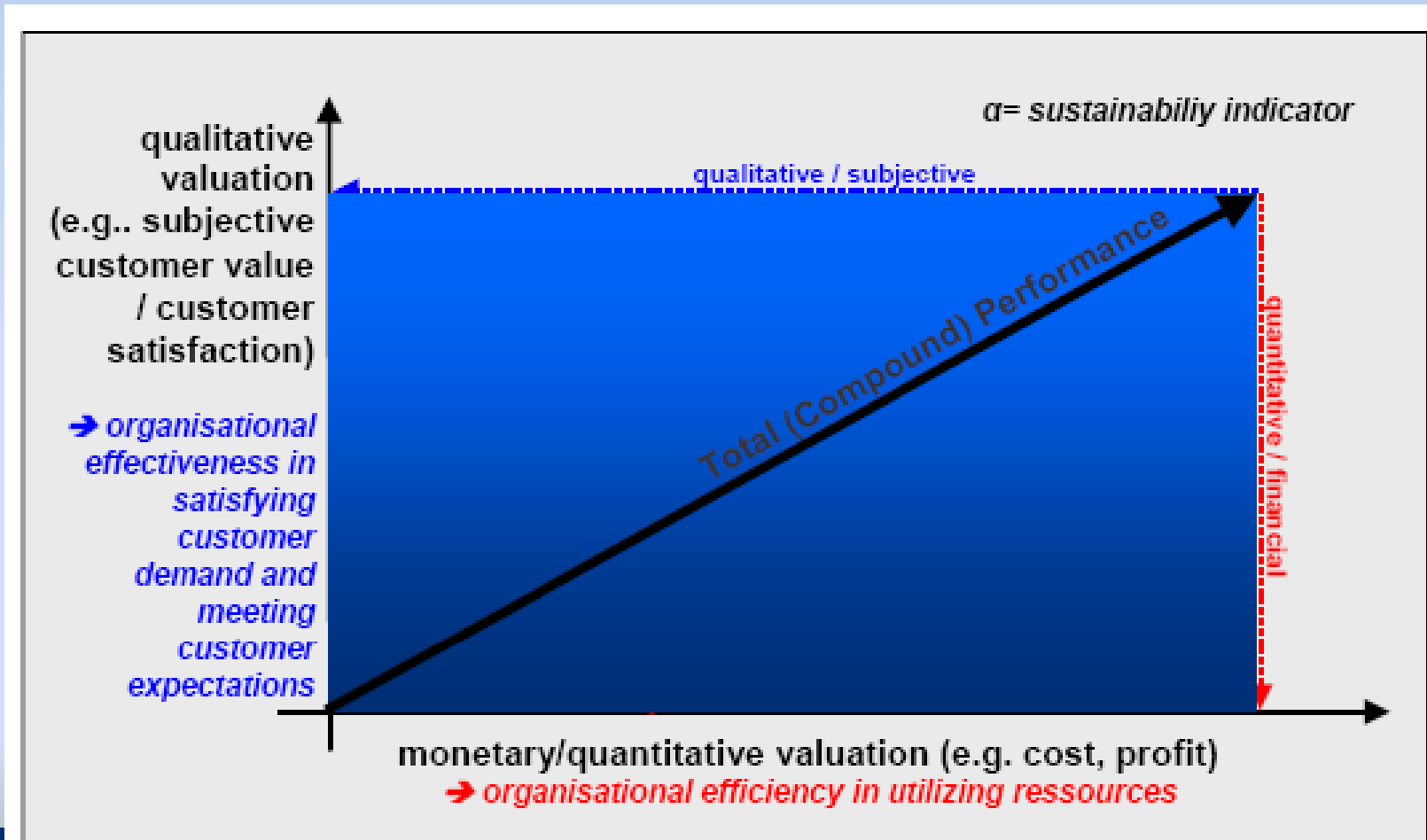
Tangibles & Intangibles /2

- Need to be considered concurrently
- Tangibles :
 - quantifiable assets: physical and logical elements, economic performability, technical attributes (reliability, maintainability, vulnerability, etc.), environmental conditions and requirements, resources and their attributes (e.g. scarceness, price, affordability), attributes of the end user service (e.g. quality, price, affordability).
- Intangibles:
 - qualitative elements which shape the definition and use of the infrastructure. E.g.: mood (of users, society, stakeholders), values and ethical positions, training of personnel, perception and acceptance of risk, awareness of vulnerabilities, policies of the business actors, strategic national and industrial objectives, geopolitical objectives, etc.

Approaches to Infranomics

- **Positive Infranomics:**
 - what are the infrastructures, which are their structural, functional and behavioral elements, and how they are managed, regulated, etc.
- **Normative Infranomics:**
 - which could be the most appropriate ways and means for managing the infrastructures and their systems in different circumstances
- **Theoretical Infranomics:**
 - the development of the concepts and models that describe the relations, activities, layers, interactions, cost and prices, etc.
- **Empirical Infranomics:**
 - the experimental demonstration and validation of theories, comprising the methods and tools for designing, running and analyzing the results of experiments, and mainly with respect to the failure of the infrastructural systems.

Tangible and Intangibles – A Vectorial Approach



Laying-out Pipelines Across Caspian – Black Sea Area



Model Insights

ASSESSING THE INTANGIBLES - THE METHOD ASSUMPTIONS/FOUNDATIONS

- 1) **ENERGY SECURITY** (of Project) = $VSUM$ [**ENERGY SECURITY** (of Project Player)]
 $VSUM$ – vector sum over all Project Players
- 2) **ENERGY SECURITY** (of Project Player) = **PROFITABILITY** (secured by Player) \times **OPERABILITY** (secured by Player)
 \times – cartezian product
- 3) **PROFITABILITY** (secured by Player) = SUM [**TANGIBLE (T) ASSET SCORES**]
 SUM – algebraic sum over scores (-10 to 10) assigned to T-assets by brain tanks
- 4) **OPERABILITY** (secured by Player) = SUM [**INTANGIBLE (I) ASSET SCORES**]
 SUM – algebraic sum over scores (-10 to 10) assigned to I-assets by brain tanks
- 5) **TANGIBLE ASSETS** – Factbook (e.g. CIA Factbook) *Numeric* Country Indicators (e.g. GDP/capita, pipeline lengths...)
INTANGIBLE ASSETS – Factbook (e.g. CIA Factbook) *Verbose* Country Indicators (e.g. governance, religions...)

Dealing with a Matrix for Tangibles / Intangibles



» PROJECT SECURITY ASSESSMENT, by PLAYERS

- Tier 1: Good Profitability and Good Operability. Security - GOOD.
- Tier 2: Poor Profitability and Good Operability. Security - MODERATE.
- Tier 3: Good Profitability and Poor Operability. Security - POOR.
- Tier 4: Poor Profitability and Poor Operability. Security - UNACCEPTABLE.

A Decision Support System

[Exit](#)
[full screen mode](#)

ODU-ONLINE

Assessing the Intangibles

version October 2008
by A.V. Gheorghe, Batten Chair, Norfolk
& D. Vamanu, Rs. Associate, Bucharest

 Old Dominion UNIVERSITY

Batten Chair of Systems of Systems Engineering



* PLAYERS

* ASSETS

* ASSESS COUNTRIES BY SYSTEMS

* ASSESS PROJECT BY COUNTRIES

* Close Program

ODU-ONLINE

Assessing the Intangibles

» The Assets

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Batten Chair of Systems of Systems Engineering



* Back

Select Player

Aruba / aa.txt



Open Player File

CIA - The World Factbook -- Romania

Background: The principalities of Wallachia and Moldavia - for centuries under the suzerainty of the Turkish Ottoman Empire - secured their autonomy in 1856; they united in 1859 and a few years later adopted the new name of Romania. The country gained recognition of its independence in 1878. It joined the Allied Powers in World War I and acquired new territories - most notably Transylvania - following the conflict. In 1940, Romania allied with the Axis powers and

Assets Featuring Player

Notes: Retain only the assets that are relevant to the assessment.
To eliminate assets, or edit asset attributes, click asset and go as directed.
Types: n(umeric), v(erbose). Category: t(angible), i(ntangible).
Impact Rank: 0.0 to 1.0.

Save Retained Assets

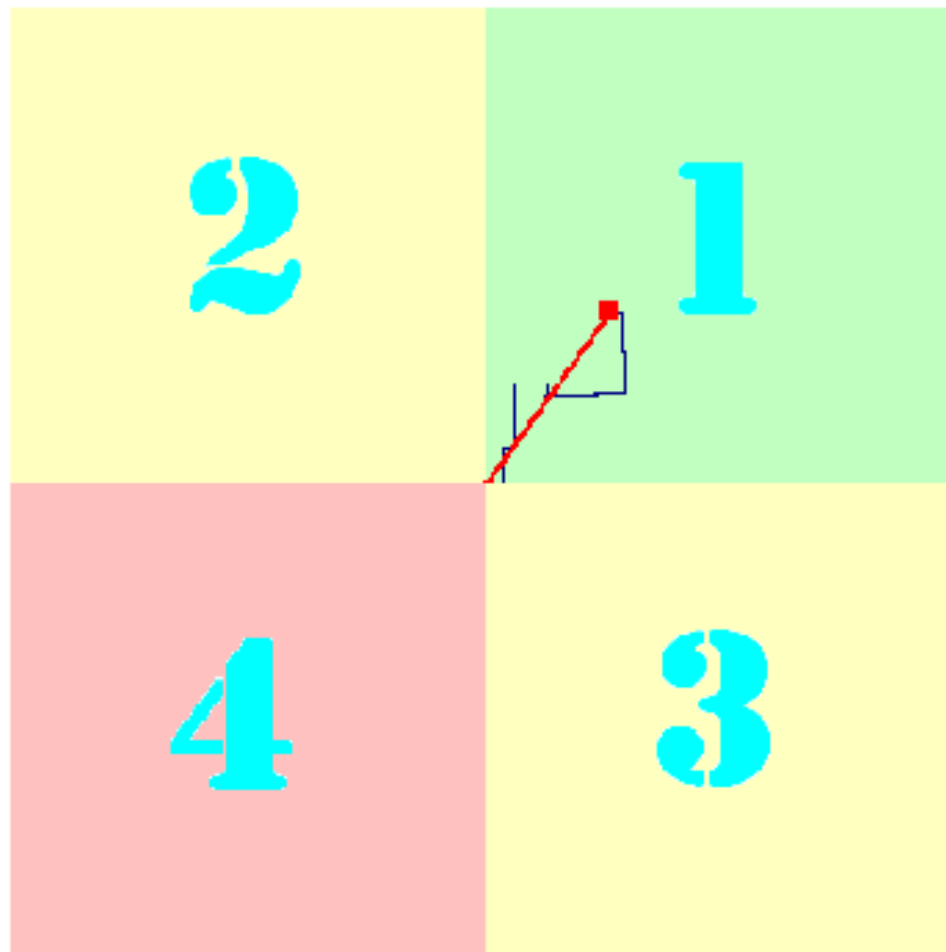
Asset	Value	System	Type	Category	Working Score
Background	The principalities of Wallachia and Moldavia - for centuries under the suzerainty of the Turkish Ottoman Empire - secured their autonomy in 1856; they united in 1859 and a few years later adopted the new name of Romania. The country gained recognition of its independence in 1878. It joined the Allied Powers in World War I and acquired new territories - most notably Transylvania - following the conflict. In 1940, Romania allied with the Axis powers and participated in the 1941 German invasion of the USSR. Three years later, overrun by the Soviets, Romania signed an armistice. The post-war Soviet occupation led to the formation of a Communist "people's republic" in 1947 and the abdication of the king. The decades-long rule of dictator Nicolae CEAUSESCU, who took power in 1965, and his Securitate police state became increasingly oppressive and draconian through the 1980s. CEAUSESCU was overthrown and executed in late 1989. Former Communists dominated the government until 1996 when they were swept from power. Romania joined NATO in 2004 and the EU in 2007.	HISTORY	v	i	1069
Location	Southeastern Europe, bordering the Black Sea, between Bulgaria and Ukraine	NATURE	v	i	75
Geographic coordinates	46 00 N, 25 00 E	NATURE	n	t	46
Map references	Europe	NATURE	v	i	7
Area total	237500 sq km	NATURE	n	t	237500
land	230340 sq km	NATURE	n	t	230340
water	7160 sq km	NATURE	n	t	7160
Area - comparative	slightly smaller than Oregon	NATURE	v	i	29

adjective	Romanian	DEMOGRAPHY	v	i	9
Ethnic groups	Romanian 89.5%, Hungarian 6.6%, Roma 2.5%, Ukrainian 0.3%, German 0.3%, Russian 0.2%, Turkish 0.2%, other 0.4% (2002 census)	DEMOGRAPHY	v	i	125
Religions	Eastern Orthodox (including all sub-denominations) 86.8%, Protestant (various denominations including Reformat and Pentecostal) 7.5%, Roman Catholic 4.7%, other (mostly Muslim) and unspecified 0.9%, none 0.1% (2002 census)	CULTURE	v	i	224
Languages	Romanian (official), Hungarian, German	CULTURE	v	i	39
Literacy definition	age 15 and over can read and write	CULTURE	v	i	35
total population	98.4%	CULTURE	n	t	98.4
male	99.1%	CULTURE	n	t	99.1
female	97.7% (2003 est.)	CULTURE	n	t	97.7
Country name conventional long form	none	ADMINISTRATION	v	i	5
conventional short form	Romania	ADMINISTRATION	v	i	8
local long form	none	ADMINISTRATION	v	i	5
local short form	Romania	ADMINISTRATION	v	i	8
Government type	republic	ADMINISTRATION	v	i	9
Capital name	Bucharest	ADMINISTRATION	v	i	10
geographic coordinates	44 26 N, 26 06 E	ADMINISTRATION	n	t	44
time difference	UTC+2 (7 hours ahead of Washington, DC during Standard Time)	ADMINISTRATION	v	i	61
daylight saving time	+1hr, begins last Sunday in March; ends last Sunday in October	ADMINISTRATION	v	i	63
Administrative divisions	41 counties (judete, singular - judet) and 1 municipality* (municipiu); Alba, Arad, Arges, Bacau, Bihor, Bistrita-Nasaud, Botosani, Braila, Brasov, Bucuresti (Bucharest)*, Buzau, Calarasi, Caras-Severin, Cluj, Constanta, Covasna, Dimbovita, Dolj, Galati, Gorj, Giurgiu, Harghita, Hunedoara, Ialomita, Iasi, Ilfov, Maramures, Mehedinti, Mures, Neamt, Olt, Prahova, Salaj, Satu Mare, Sibiu, Suceava, Teleorman, Timis, Tulcea, Vaslui, Vilcea, Vrancea	ADMINISTRATION	n	t	41

ports - partners	Italy 15.5%, Germany 14%, Russia 8.3%, France 6.8%, Turkey 4.9%, China 4.1% (2005)	ECONOMY	v	i	83	8.21
reserves of foreign exchange and gold	27.88e9 (2006 est.)	ECONOMY	n	t	2.788e10	6.87
Debt - external	42.76e9 (2006 est.)	ECONOMY	n	t	4.276e10	8.27
currency (code) leu (ROL) is being phased out in 2006; /" leu (RON) was introduced in 2005 due to currency revaluation	10000 ROL = 1 RON	ECONOMY	n	t	10000	2.25
currency code	ROL	ECONOMY	v	i	4	-4.59
exchange rates	lei per US dollar - 2.84 (2006), 3 (2005), 3 (2004), 3 (2003), 3 (2002)	ECONOMY	v	i	72	8.41
Fiscal year	calendar year	ECONOMY	v	i	14	-4.19
phones - main lines in use	4.391e6 (2005)	INFRASTRUCTURE	n	t	4.391e6	2.37
phones - mobile cellular	13.354e6 (2005)	INFRASTRUCTURE	n	t	1.3354e7	9.20
phone system general assessment	rapidly improving domestic and international service, especially in wireless telephony	INFRASTRUCTURE	v	i	87	3.74
domestic	90% of telephone network is automatic; liberalization in 2003 is transforming telecommunications; there has been 20% growth in fixed lines with a penetration rate of 58% of households; nation-wide wireless service is growing even faster with four major providers and a penetration rate of 32%	INFRASTRUCTURE	n	t	90	7.09
international	country code - 40; satellite earth station - 10 (Intelsat 4); digital, international, direct-dial exchanges operate in Bucharest (2005)	INFRASTRUCTURE	v	i	136	0.80
radio broadcast stations	AM 40, FM 202, shortwave 3 (1998)	INFRASTRUCTURE	v	i	34	-3.83

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» Assessment by INFRASTRUCTURE SYSTEM - Romania



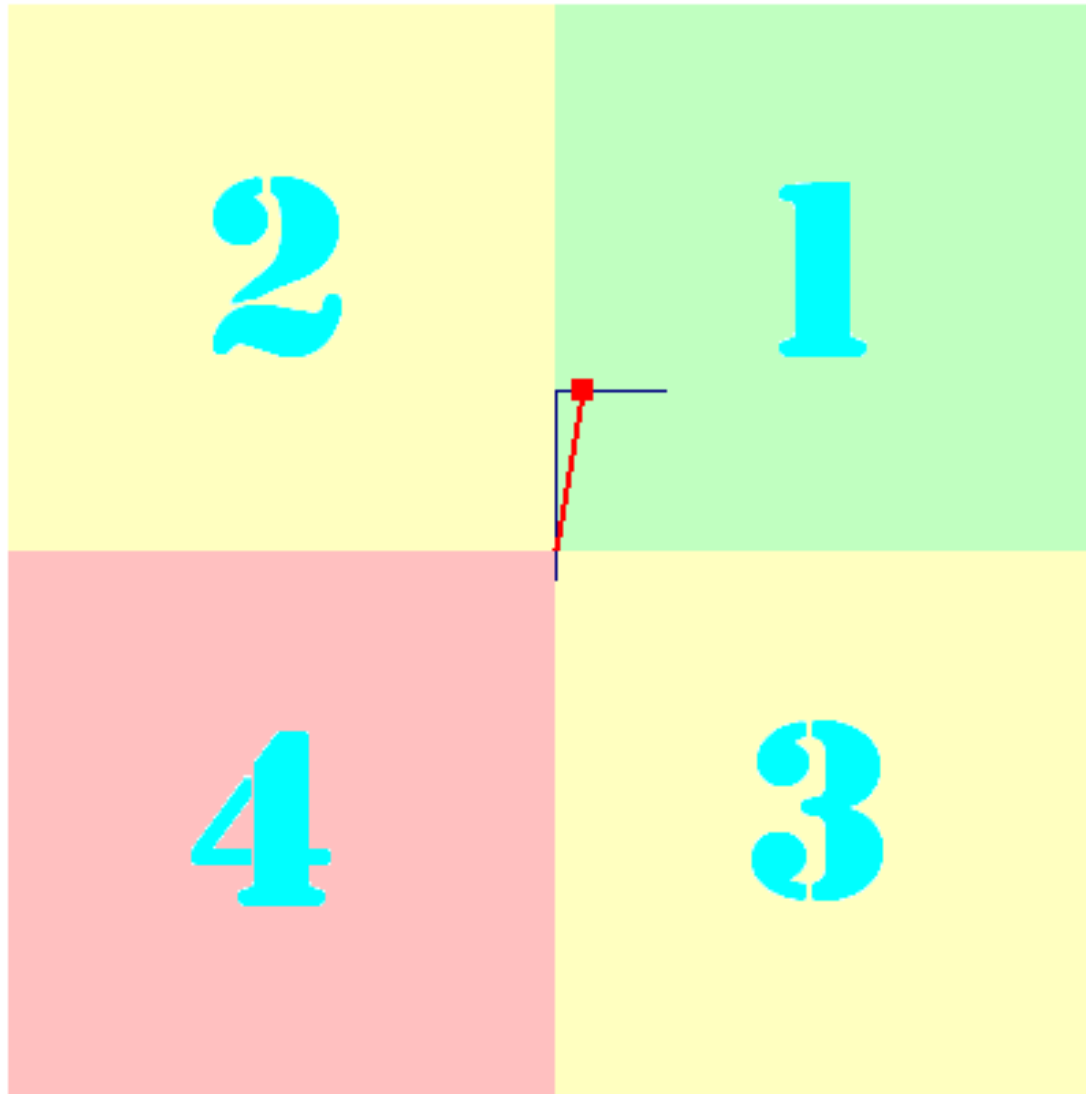
- Profitability Index of INFRASTRUCTURE: 0.26
- Operability Index of INFRASTRUCTURE: 0.36



J



» Assessment by CULTURE SYSTEM - Romania



- Profitability Index of CULTURE: 0.05
- Operability Index of CULTURE: 0.30

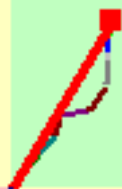
ASSESSMENY BY COUNTRY as a SYSTEM OF SYSTEMS - Romania

Systems contributing (v. above):

- Infrastructure;
- Economy;
- Nature;
- Demography;
- Administration;
- Politics;
- Defense;
- National Security;
- History;
- Culture.

2

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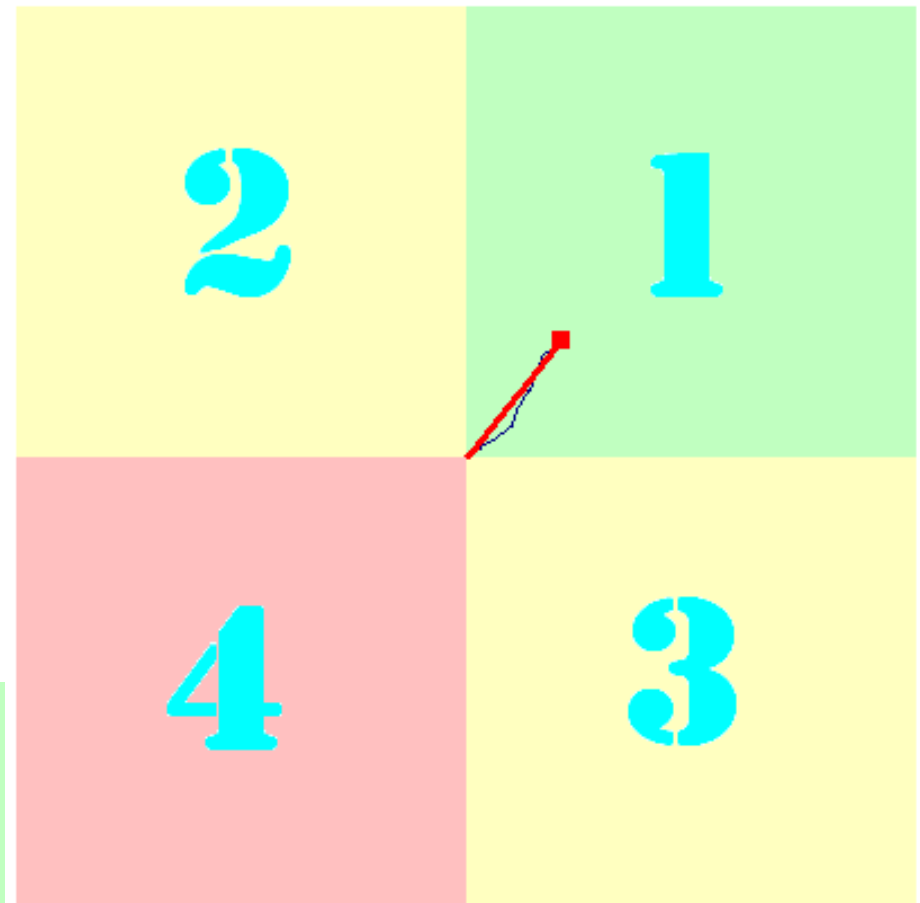


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PROJECT PLAYERS are:

- » Azerbaijan: 0.24 0.19
- » Russia: 0.28 0.19
- » Ukraine: 0.29 0.24
- » Hungary: 0.09 0.30
- » Austria: 0.23 0.30
- » Germany: 0.11 0.26
- » France: 0.13 0.35
- » Italy: 0.32 0.26

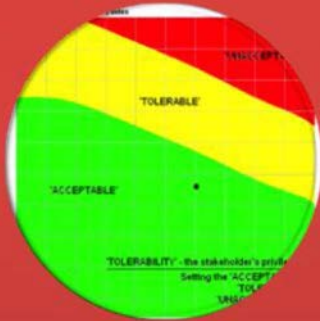


- Project Combined Profitability Index of : 0.21
- Project Combined Operability Index of : 0.26

Resilience Governance Challenges

A Need for Research

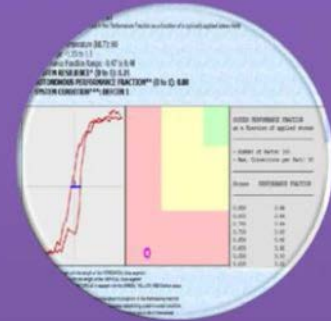
A Take on Resilience Governance



Cooperative
Modeling



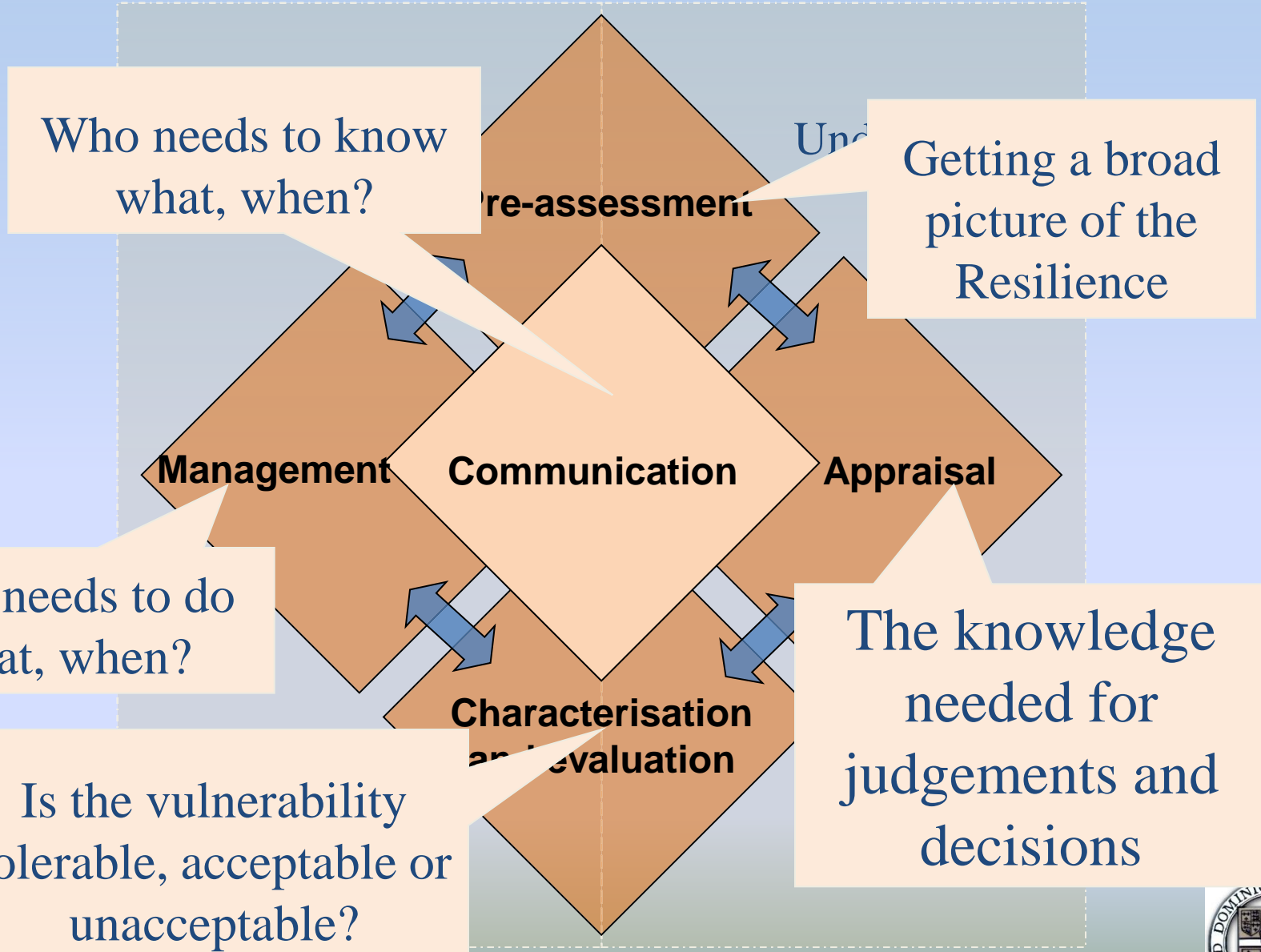
Vectorial
Approach



Hysteresis
Model



Resilience Governance Framework



Potential Governance Deficits

- **Warning:** signals of a known or perceived vulnerability have not been detected or recognised.
- **Scope:** a vulnerability which is perceived as having only local consequences may in fact be much broader (and vice-versa).
- **Framing:** different stakeholders may have conflicting views on the issue
- **Black swans:** no awareness of a hazard or possible vulnerability
- **Exclusion:** when some stakeholders and their views or significant benefits and other consequences are **accidentally or deliberately excluded** from the evaluation process
- **Indecision:** when there is indecision or **lack of responsiveness**, whether voluntary (act of authority) or involuntary (overly inclusive process with stakeholders leads to inertia)
- **Transparency:** when tradeoffs are not made explicit and hidden agendas seem to determine the outcome of the evaluation process

Issues of Concern

How do values and emotions impact on how the vulnerabilities are perceived?

- What are the public's **concerns and perceptions**?
- What is the **social response** to the resilience? Is there the possibility of political mobilisation or potential conflict?
- What role are existing institutions, governance structures and the media **playing in defining public concerns**?
- Are managers likely to face important ambiguities arising from **differences in stakeholder objectives and values, or from inequities in the distribution of benefits and resiliencies**?

Modeling & Simulation

- The modeling of infrastructural “system-of- systems” cannot just be the juxtaposition of the models of the system-components.
- When taken into account abnormal situations, the patchwork of models is manifestly insufficient.
- Whether a model is appropriate or not depends on the extent to which it promotes understanding.
- What the concept of Infranomics tells us is that many modeling and simulation approaches valid for “relatively small”, system-level, security problems, fall short of providing a workable answer to system-of-systems problems.

Questions?

Thank you