ABOUT INSTITUTIONALVIABILITY

Gratiela-Denisa IORDACHE [6]

Abstract:

The present paper aims to define, in terms of logical analysis, the concepts of the institutional viability and its mathematical model for a complex organization.

In the context of the strong debates on the model of the future development of the European Union, from institutional point of view, in the actual context of economic and social turbulences, the fully understanding of the concept of institutional viability is a helpful tool for designing the future of the European Union Institutional System. In defining the concept, I choose to use method of sufficiency predicates (logical analysis).

The results of the paper will be useful in finding ways for increasing the efficiency of the European Union's institutions and their viability.

Keywords: *Institutional viability, European Union, sustainability*

JEL Classification: *E50, E60, E70*

Introduction

The concept of viability has gathered increasing attention across disciplines, from economics to organizational theory and systems science.

Viability is not a static state; it involves an ongoing process of adaptation and regulation. For example, in economic systems, viability could mean a balance between growth and resource consumption that ensures the system can sustain itself in the long run. In ecological terms, it may refer to the ability of an ecosystem to maintain biodiversity and resilience in the face of environmental stresses.

At its core, viability refers to the capacity of a system to maintain its essential functions and adapt to changing conditions while ensuring long-term sustainability. In the context of complex systems—be they economic or social—the viability of the system is crucial for its survival and growth. This article will explore the concept of viability in systems, focusing on its definition, applications, methodologies for analysis, and implications for the future.

Description of the Problem

The key issue of the article lies in defining and modelling the viability in a way that applies to different types of systems/organizations.

[6] PhD, MBA, Romanian Academy School of Advanced Studies, Calea Victoriei, Bucharest, Romania, e-mail: gra_den@yahoo.com

Moreover, understanding the conditions that impact the viability of complex systems, including internal dynamics, external forces, and feedback mechanisms, is essential for making informed decisions in policy, management, and design.

Methodology and Data

1. To analyze the viability of a system, we can use various systems theory and cybernetic approaches that incorporate feedback loops, adaptation strategies, and performance indicators. In this paper, I proposed the use of *Stafford Beer's Viable System Model* (VSM) (Beer, S., 1979) that offers a mathematical and conceptual framework for evaluating the viability of organizations and institutions, considering their structures, communication channels, and decision-making processes.
2. Another method I used in defining the viability concept is the *method of sufficiency predicates* introduced by Prof. Univ. Dr. Ene Dinga [1] (Dinga, E., 2009) based on the "Treatise on Logic" by Enescu, G.(Enescu, G., 1997)[2]. This method is a tool used with predilection in logic and philosophy to define a concept by identifying a set of conditions or predicate attributes that are sufficient to attribute the concept in question to an object or entity.

Method of sufficiency predicates

Due to its innovative character, I will describe the fundamental concepts of the method. So, a sufficiency attribute is a property or attribute that, once fulfilled by an object or entity, implies that that object or entity is part of the category defined by the respective concept.

The method of logical analysis of sufficiency attributes is used to describe a concept N as the result of its sufficiency attributes/attributes.

So, we can describe an abstract notion by the equation:

N = {A1, A2, ..An},

where N is the abstract concept(notion) and A1, A2, ..., An are the identified sufficiency attributes(properties).

Defining concepts by the sufficiency attribute method involves several steps, namely:

a. Identifying the sufficiency attributes that completely define the abstract notion N;

b. Qualitative analysis of the identified sufficiency attributes which involves the following steps:

- Verifying the requirements that must be met by the pairs of sufficiency attributes identified as necessary for defining the notion, namely:

  i. independence (no sufficiency attribute is the logical result of another);

  ii. consistency (no sufficiency attribute is contradictory to another).

c. Checking the completeness of the sufficiency attributes so that they can generate a notion.

Institutional Viability Concept

a. Identifying the sufficiency attributes that completely define the abstract notion Viability-L:

- Self-duplication (D) - the ability of a phenomenon / process / system to duplicate itself, in response to external shocks, without the intervention of an external device
- Adjustability (A) - the ability of a phenomenon / process / system to adjust or modify itself to maintain its state parameters, in response to external shocks, without the intervention of an external device

- Continuity (C) - the ability of a phenomenon / process / system to maintain its state parameters uninterrupted in space and time, in response to external shocks, without the intervention of an external device

So, from a logical point of view, it is defined by the following equation:

$$L=(D)\wedge(A)\wedge(C)$$

Consequently, I will define *Viability as the ability of a phenomenon / process / system to replicate its structure, adapting to the external environment to preserve the value of its state parameter and to maintain its state parameters uninterrupted in space and time, in response to external shocks, without the intervention of an external device.*

The following step of the process of defining the Viability concept is the Completeness Analysis:

- Analyzing the list of identified sufficiency attributes:

• Self-Duplication (D) - The ability of a phenomenon / process / system to replicate itself, in response to external shocks, without the intervention of an external device

• Adjustability (A) - the ability of a phenomenon / process / system to adjust or modify itself to maintain its state parameters, in response to external shocks, without the intervention of an external device

• Continuity (C) - the ability of a phenomenon / process / system to maintain its state parameters uninterrupted in space and time, in response to external shocks, without the intervention of an external device

We conclude that this completely defines the concept of Viability.

The next step is Independence Analysis:

Independence analysis assumes that none of the attributes is the logical result of another. Therefore, we have the following:

- D does not imply A and vice versa: the ability of a phenomenon/process/system to replicate itself does not imply that the system/process/phenomenon has the ability to adjust or modify itself to maintain its state parameters, in response to external shocks, without the intervention of an external device and vice versa- to adjust or modify itself to maintain its state parameters, in response to external shocks, without the intervention of an external device does not imply that the phenomenon/process/system has the ability to replicate itself.
- D does not imply C and vice versa: the ability of a phenomenon/process/system to replicate itself does not imply that the system/process/phenomenon has the ability to maintain its state parameters uninterrupted in space and time, in response to external shocks, without the intervention of an external device and vice versa - the ability of a phenomenon/process/system to maintain its state parameters uninterrupted in space and time, in response to external shocks, without the intervention of an external device does not imply that the phenomenon/process/system has the ability to replicate itself, in response to external shocks, without the intervention of an external device
- C does not imply A and vice versa: the ability of a phenomenon/process/system to maintain its state parameters uninterrupted in space and time, in response to external shocks, without the intervention of an external device does not imply that the system/process/phenomenon has the ability to replicate itself, in response to external shocks, without the intervention of an external device and vice versa - the ability of a phenomenon/process/system to replicate itself, in response to external shocks,

without the intervention of an external device does not implies the ability of a phenomenon/process/system to maintain its state parameters uninterruptedly in space and time, in response to external shocks, without the intervention of an external device.

The next paragraph is about Consistency Analysis :

Consistency analysis assumes that none of the attributes is contradictory to another. Therefore, we have the following:

• D does not contradict A: the ability of a phenomenon/process/system to replicate does not contradict the fact that the system/process/phenomenon has the ability of a phenomenon/process/system to adjust or modify itself to maintain its state parameters, in response to external shocks, without the intervention of an external device

• D does not contradict C: the ability of a phenomenon/process/system to replicate does not contradict the fact that the system/process/phenomenon has the ability to adjust or modify itself to maintain its state parameters, in response to external shocks, without the intervention of an external device

• C does not contradict A: the ability of a phenomenon/process/system to maintain its state parameters uninterrupted in space and time, in response to external shocks, without the intervention of an external device does not contradict the fact that the system/process/phenomenon has the ability to replicate, with or without the help of an external device.

As a species of the genus Viability, Institutional Viability can be defined as *the ability of an institutional system to duplicate its structure, adjusting to the external environment to preserve the value of its state parameter and to maintain its state parameters uninterrupted, in space and time, in response to external shocks, without the intervention of an external device*

Proposal for a mathematical model applied to institutions described as viable systems

The Viable System Model (VSM), developed by Stafford Beer (Beer, S.,1995), is a systems theory framework that describes how complex systems (like organizations or institutions) maintain their viability by performing essential functions and interacting with their environment.

The VSM suggests that to remain viable, a system must have the following components:

- System 1: Operational units that perform the day-to-day functions of the organization.
- System 2: Coordination mechanisms to ensure stability between operational units.
- System 3: Control systems that provide operational oversight and resource management.
- System 4: Intelligence systems that provide foresight and adaptability to external challenges.
- System 5: Policy-making mechanisms that set the strategic direction of the system.

In our attempt to elaborate a model for a complex institution using Viability System Model model, we will develop a set of equations that describe each of the system's five components, their interactions and the overall viability of the system. Thus:
1. *Subsystem 1 (Operational)* – Daily activities of the organizations

Mathematical formalization:

Let there be a variable Z_t that represents the state of subsystem 1 at time t. This variable can be in the form of economic indicators (or in the form of implemented policies

The following system of differential equations can describe the evolution of these indicators over time [3].((Strogatz, 2018)

$$dZ_t/dt = f(Z_t, D_t)$$

Where:

- Z_t is the state vector of subsystem 1 at time t,

- D_t represents the decisions taken by the management subsystems (subsystems 2 and 3),

- $f(Z_t, D_t)$ is a function that describes how operational actions interact with the organization's policies.

2. *Subsystem 2 (Coordination)* – Organization's Governance

The coordination subsystem refers to the organization's structural units, which are responsible for decision-making and coordination of actions between the organization's elements

Mathematical formalization:

Given the attributions of this subsystem, I consider that an optimal modeling option is the decision function [4] H_t, which represents the actions and decisions taken by the units of the organization at a given time:

$$H_t = I(Z_t, E_t)$$

Where:

- Z_t is the operational state of the organization,

- E_t represents the external environment

- $I(Z_t, E_t)$ is a decision function based on the interaction between the state of the operational subsystem and external factors.

3. *Subsystem 3 (Control)* - Supervision and Regulation

This includes the development of rules and regulations, as well as monitoring their compliance.

Mathematical formalization:

I propose that this subsystem be described by a feedback function [5] because it represents a mechanism by which the outputs of a system are reintroduced as inputs to influence future states of the system, and can therefore describe the functions of supervision and regulation. Thus:

$$S_t = r(Z_t, H_t)$$

Where:

- S_t is the control vector of the organization

- Z_t is the state of the operational subsystem at time t

- H_t are the decisions taken by the bodies of subsystem 2,

- $r(Z_t, H_t)$ is the control function that regulates actions depending on the state of subsystem 1 and the decisions of the institutions of subsystem 2.

4. *Subsystem 4 (Analysis)* - Strategic Planning

Subsystem 4 is responsible for developing strategies based on the analyses made in order to adapt to external changes.

Mathematical formalization:

Mathematically, this subsystem can be represented by a forecasting and planning model that determines the strategic directions of the EU:

$$A_t = w(Z_t, S_t)$$

Where:

- A_t is the strategic plan of the organization
- Z_t is the state of subsystem 1,
- S_t is the control established by subsystem 3 (regulations and interventions),
- $w(Z_t, S_t)$ is the strategic planning function that adapts the organization's actions in the long term.

5. *Subsystem 5 (Political)* - regulates how decisions are made and how policies are implemented.

Mathematical formalization:

I propose the use of a normative function [6] P_t, which imposes regulations on the entire system:

$$P_t = u(A_t, H_t)$$

Where:

- P_t is the political vector that regulates the fundamental values and principles of the organization,
- A_t is the strategy,
- H_t are the decisions,
- $u(A_t, H_t)$ is the normative function that imposes constraints and defines how decisions are made.

The complete mathematical model of the organization as a viable system, consisting of the five subsystems mentioned, is described by the following equations that reflect how the subsystems interact with each other and how they self-regulate to ensure the viability of the organization in a dynamic environment:

$$dZ_t/dt = f(Z_t, D_t)$$

$$H_t = l(Z_t, E_t)$$

$$S_t = r(Z_t, H_t)$$

$$A_t = w(Z_t, S_t)$$

$$P_t = u(A_t, H_t)$$

Results

- The use of method of sufficiency attributes contributes to a clear understanding of complex concepts
- The above model may be used to understand:

a. Threshold Effects: Certain thresholds of governance, legitimacy, adaptability, or collaboration may trigger significant changes in institutional viability.

b. Resilience to External Shocks: The model can identify which factors are most susceptible to external shocks and how the institution can improve its resilience to these shocks. For instance, an institution with high adjustability A(t) may be more capable of surviving environmental or economic crises.

c. Optimal Policy Interventions: The model can suggest which areas require intervention (e.g., improving collaboration, increasing legitimacy) to boost institutional viability. It can also help identify policies or practices that increase the overall resilience of the institution.

Conclusions

The concept of viability provides valuable insights into the dynamics of complex systems. Whether applied to ecosystems, economies, or social organizations, understanding and assessing viability enables us to make better decisions about resource management, policy development, and system design.

For systems to remain viable, they must be capable of adapting to both internal and external changes while maintaining their core functions. This requires fostering resilience, sustainability, and flexibility across different sectors, whether it involves financial institutions, environmental policies, or social structures. The future of institutional viability depends on the ability of institutions to remain responsive to changing conditions, while ensuring that they continue to fulfill their essential functions and maintain legitimacy in the eyes of their stakeholders.

The proposed simplified mathematical model captures the dynamic interrelationships between the key subsystems of the organization, as outlined by the Viable System Model (VSM). The model highlights how each subsystem (operations, coordination, control, intelligence, and policy) influences and is influenced by the others. By using these equations, we can study how the complex institutions adapt over time to various internal and external pressures and identify strategies to maintain its viability in a complex, ever-changing global environment.

Future Directions

Future research on viability should focus on developing integrated models that account for the interconnectedness of different types of systems/organizations.

Additionally, advancing data collection techniques and computational models will improve our ability to predict the viability of systems under various scenarios. This will allow policymakers, managers, and stakeholders to make more informed decisions that balance short-term goals with long-term sustainability.

Finally, addressing social and cultural factors in the viability of systems—such as values, behaviors, and institutional trust—will be crucial for creating sustainable societies and organizations in the future.

Further research can focus on refining the model by adding more specific factors, such as social capital or political stability, and expanding its application to different types of institutions (e.g., national governments, corporations, international organizations). Ultimately, a deeper understanding of institutional viability will help ensure that institutions remain resilient in an increasingly uncertain and complex world.

Text notes

[1] Dinga E., Studii de economie. Contribuții de analiză logică, epistemologică și metodologică, Editura Economică 2009, București, pag.79-84.

[2] Enescu Gh., - Tratat de logică, Editura Lider, București, pag. 71-77 ISBN/Cod: 973-97836-5-1, 1997.

[3] Strogatz, S.H., 2018. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. 2nd ed. CRC Press.

[4] A decision function is a function that associates each possible state or set of conditions with a specific outcome or choice. It can be viewed as a function that describes how decisions are made in a given context, based on predefined factors or criteria. Formalization:

Suppose we have a set of possible options and a set of decision criteria or information that influences the choice. The decision function can be formalized as follows:

- Let X be a set of options (actions or strategies).

- Let S be a set of states or conditions that can influence the decision (the current state of a system).

- The decision function $H: S \rightarrow X$ is a function that associates each state $s \in S$ with an option $x \in X$, such that $H(s) = x$.

This means that, for each state s in the set S, the function H chooses an element $x \in X$, which represents the decision made in that state. (Espejo, R., Harnden, J.R., and Bichler, R., 2019.)

[5] A feedback function can be described as a mathematical relationship that defines how an output variable (or the result of a process) is used to modify the inputs of a system, in order to regulate its behavior. Formally, a feedback function can be described as:

$x(t+1) = f(x(t), u(t))$,

where:

- $x(t)$ is the state of the system at time t,

- $u(t)$ is the input to the system at time t (which may be influenced by previous outputs),

- f is the feedback function that determines how the inputs and outputs interact and influence the future evolution of the system.

[6] A normative function can be described as a function that defines what is considered "correct" or "optimal" in a given context, guiding the decision-making process to achieve a goal. This may involve setting a goal or a set of rules that must be followed to achieve a desired outcome.

Mathematically, a normative function can be viewed as an objective function in an optimization process, which determines what should be maximized or minimized in a given system. Thus, the normative function $f(x)$ can be used to evaluate a solution, and the optimal solution will be that value of x that minimizes or maximizes $f(x)$, depending on the established objectives.

$f(x)$ = the objective to be optimized, where x represents the decision variables of the system. (March & Simon, 1958).

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