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Phenomenon of equilibrium and limit states in security sciences

Introduction

Basic terms such as 'phenomenon', 'event', 'state', and 'situation' are defined for risk analysis and security needs. Other important terms include 'equilibrium' and 'stability' (as well as related terms 'instability' and 'lability'). These terms can be found in both security and technical sciences as well as economics and social sciences. This paper generally defines and explains these key concepts across different disciplines and fields of human activity.

Equilibrium states are known mainly from the field of physics - mechanics of solids. However, equilibrium states, stability and their changes are of great importance in the analysis of risks and safety, of various processes and objects in engineering practice, but also in other areas of human activity.

Steady state analyzes help to understand, define threats and risks and manage them effectively; improve the reliability, safety of technological and other components or units. The paper is mainly of a theoretical nature and originated in research within the security sciences.

Balance, equilibrium state, equilibrium position, stability

It is generally known that when objects, systems or processes, actions, or events,[1] are in equilibrium, equilibrium states, or equilibrium positions, and are capable of maintaining stability, they are, in a certain sense, safe over time, that is, there usually are no unexpected security incidents, actions, or events associated with them. In short, they behave as we expect (as they were designed, projected, manufactured, tested, etc. to do). Only after losing their equilibrium, equilibrium state, or equilibrium position, and consequently their stability, do security events or incidents occur, causing damage or harm.[2] Therefore, equilibrium and stability are important characteristics of objects, systems, or processes that determine their behaviour in terms of security.[3]

The concepts of equilibrium, equilibrium state, equilibrium position, balance of forces, and stability are not generally defined, but rather their definitions are usually targeted to certain occupational areas. Among the many synonyms of the word 'stability' are steadiness, fixity, equalisation, balance, constancy, constancy of

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[1] PORADA, Viktor a kol. *Bezpečnostní vědy*. Plzeň: Vydavatelství a nakladatelství Aleš Čeněk, s.r.o., 2019. 780 pp. ISBN 978-80-7380-758-0.
[2] ŠIMON, L. *Public security activities*, Bratislava, 2016, pp. 149. ISBN 978-80-8054-686-1.
[3] SEKYROVÁ, J., KOPENCOVÁ, D., MANAS, R. *Documentation methods of forensic crime scene*, Czech Ministry of Interior, Prague, MV-39230-1/VO-2010, evidence number 9/2010, 2010.

properties, persistence, and consistency. In general, 'equilibrium' means 'being in line' or 'being mutually balanced'. The antonym of stability is 'lability'.

Balance, equilibrium

Equilibrium is generally the state of a system when the actions in all directions are mutually aligned. The concept of equilibrium may have several meanings.

The concept of a balance of forces is encountered in various areas, such as the military, economics, business, sport, etc. By 'forces', we can mean things like the forces of nature, physics, military, politics, society, religion, hostile actions, criminality, etc.

By the 'balance of forces', we mean a balance that generally leads to stability. All the forces are balanced, that is, no force prevails over any other forces.

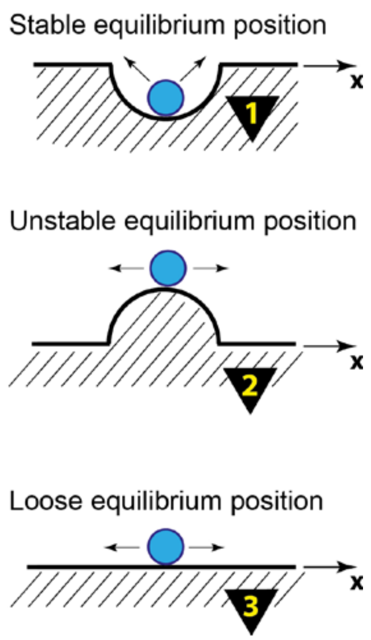

Fig. 1 Illustrative representation of equilibrium positions in solid mechanics

Equilibrium position

In physics (mechanics), **the equilibrium position** is defined as the position of a solid body at which the resultant of all the forces acting on the body is zero, and the resultant torque of all the forces is zero as well. The equilibrium position is a position resulting from the balance of forces.

And vice versa:

The balance of forces is the state when several forces act on the body, but their resultant is zero, and the resultant force moment resulting from the composition of all the force moments is also zero.

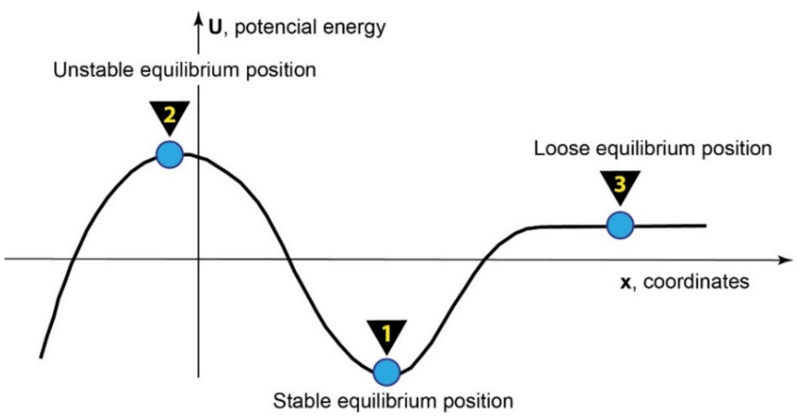

Fig. 2 The dependence of potential energy U on the x coordinate of the ball when it moves from the unstable equilibrium position to the stable and then to the free equilibrium positions

We distinguish (in mechanics) three basic equilibrium positions:

- **The stable equilibrium position** (also **the steady-state equilibrium position**) is a position wherein a body returns to its original position after it is deflected from this position, that is, the deflection gradually decreases. The potential energy of a body at steady-state equilibrium is the smallest, and it increases when deflected.

  An example is a ball located in a pit. When deflected, the ball will return to its starting position. The deflection increases the potential energy of the ball.

- **The unstable equilibrium position** (also **the labile equilibrium position**) is the position wherein a body does not return to its original position after deflection, but rather the deflection increases further. By deflecting from the unstable position, the body's potential energy decreases.

  An example is a ball located on top of a hill. When deflected from its position, the ball will always roll down and not return to its starting position on its own. The deflection decreases the potential energy of the ball.

- **The free equilibrium position** (also **the indifferent equilibrium position**) is the position wherein, when deflecting the body, neither the force resultant nor the resultant force moment acting on the body enacts change. When the body is deflected, the distance from the new position does not change (it neither increases nor decreases). When the body is deflected, its potential energy remains constant.[1]

  An example is a ball located on a horizontal plane. If we move the ball to another place, it will stay there and will neither move away from its original position nor return to it. The potential energy remains constant.

Equilibrium state

In thermodynamics, the equilibrium state is defined as the state of a thermodynamic system wherein there are no flows of extensive values (heat, mass, energy, etc.). Intensive values are often the same throughout the system in this case.

One of the thermodynamic postulates states that every system reaches its equilibrium. **Every system that is under constant external conditions from a certain point of time will spontaneously move to its equilibrium state after a certain period of time. It remains in this state as long as the external conditions remain the same.**

The aforementioned statement is general, in that it applies both to the natural, social, political[2,3] and other equilibrium states that are characteristic of objects, systems, and processes. In the process of every development, evolution, and so on, the equilibrium state changes, stability falls, and consequently new equilibrium states

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[1] PORADA, Viktor a kol. *Bezpečnostní vědy*. Plzeň: Vydavatelství a nakladatelství Aleš Čeněk, s.r.o., 2019, p. 630. 780 pp. ISBN 978-80-7380-758-0.

[2] ROUBAL, Ondřej. *Sociology of Branding: "Just do it" in the "No Limits" World*. Communication Today, FMK UCM Trnava: Faculty of masmedia communication of the University of St. Cyril and Metod, year. 8, No. 1, pp. 40-52., 2017, ISSN 1338-130X.

[3] ROUBAL, Ondřej. *The duality of hedonism in the ambivalent world of polarities*. European Journal of Science and Theology, Iasi: Technical University of Iasi, Year 15, No. 1, pp. 203-213, 2019, ISSN 1841-0464.

are created regularly at different lengths of time. From the social, human, or security points of view, it is always a question of whether a new equilibrium state is desirable ('must the house necessarily burn, so we may build a new one?'). In some (numerous!) security cases, it is generally undesirable to lose the stability of any current object, system, or process.[1]

Every state, every equilibrium state can be characterised by its characteristic, significant parameters and variables. Any change in a parameter that is significant for an equilibrium state (object, system, or process) can disrupt the equilibrium state and lead to the loss of stability.[2]

The loss of stability of equilibrium states is a natural phenomenon that is part of the antagonistic world in terms of evolutionary and revolutionary development.[3] While the tendency to lose the stability of equilibrium states can be reduced to a large extent by preventive tools, in most cases it is not possible to prevent stability loss.[4] The loss of equilibrium state stability can be divided into two basic types according to the courses they follow:[5]

- Soft loss of stability,
- Hard loss of stability.

This issue is mainly addressed by the mathematical 'theory of disasters' developed by Russian mathematician Vladimir Igorevich Arnold (1937–2010), French mathematician and philosopher René Frédéric Thom (1923–2002), and especially Sir Erik Christopher Zeeman (1925–2016) of Great Britain.[6]

Soft loss of stability

In the case of a soft loss of stability, an oscillating periodic mode becomes a steady mode of the system, which differs little from the equilibrium state in the beginning. The first symptoms of stability disruption may not be initially observable at all, as they arise slowly, gradually. However, a gradual change in parameters may ultimately cause a loss of system stability.[7]

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[1] BLAŽEK, Vladimír; DWORZECKI, Jacek; BUZALKA, Ján a kol. *Crisis screnarios in public administration.* Bratislava: Akadémia Policajného zboru, 2016, 304 pp. ISBN 978-80-8054-678-6.

[2] FELCAN, Miroslav. *Public order issues as one of the most important areas of public administration]*: chapter3 (author Miroslav Felcan: In: Current problems in public administration) Kristína Králiková, Mária Sabayová a kol. Bratislava: Academy of Police Corps in Bratislava, 2016, pp. 41-60. ISBN 978-80-8054-712-7.

[3] DOUGHERTY, J. E.; PFALTZGRAFF Jr., R. L. *Contending Theories of International Relations*, Addison–Wesley, New York, London, 2001.

[4] ŠIMÁK, Ladislav a kol. *Terminology dictionary of crisis management.* Žilina: University of Žilina, Faculty of security engineering, 2006, pp. 36. ISBN 80-88829-75-5.

[5] ŠIMÁK, Ladislav. *Crisis management in public administration.* Žilina: University of Žilina, Faculty of security engineering, 2015. 259 pp. ISBN 978-80-554-1165-1.

[6] PORADA, Viktor a kol. *Bezpečnostní vědy*. Plzeň: Vydavatelství a nakladatelství Aleš Čeněk, s.r.o., 2019, p. 631. 780 pp. ISBN 978-80-7380-758-0.

[7] ŠIMÁK, Ladislav. *Crisis management in public administration.* Žilina: University of Žilina, Faculty of security engineering, 2015. 259 pp. ISBN 978-80-554-1165-1.

Hard loss of stability

Accidental or deliberate immediate and fundamental changes of parameters and their manifestations of disruption of a system to such an extent that stability is completely disrupted constitute hard losses of system stability. The system leaves its equilibrium state by jumping to another developmental mode. It may be another stable stationary mode, stable oscillation around an equilibrium state, or a more complicated uneven movement.[1]

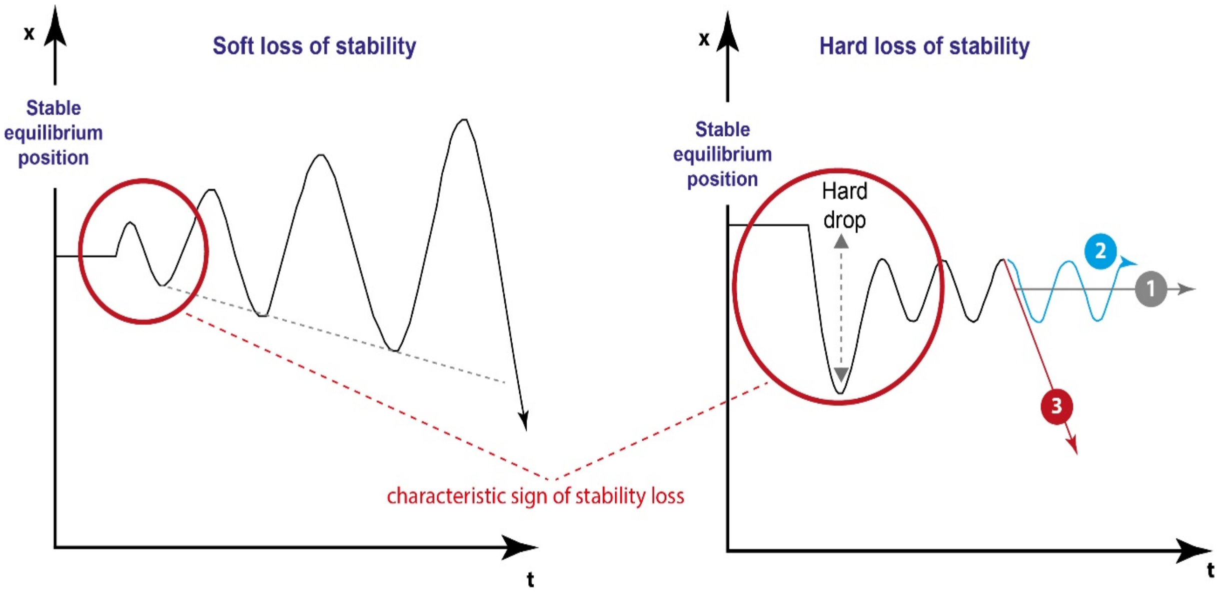

Fig. 3 Comparison of soft and hard losses of stability over time

Stability

In physics (mechanics) **stability** is defined as the difference of the potential energy of a body between its unstable position and its stable equilibrium position, or in other words the amount of work that must be completed for the body to move from its stable equilibrium position to its unstable equilibrium position.

The stability of a body directly and proportionally depends on the weight of the body, inversely proportional to the height of its centre of gravity at its stable position and directly proportional to the height of the body's centre of gravity in its unstable position.

In other physical disciplines (such as optics, chemistry, physics, electrical engineering, etc.), **stability** is defined as the **ability to maintain certain properties unchanged over time**; the humanities (such as linguistics, politics, etc.), are concerned with the **stability of links over time, links that keep a system whole**.

In a technical environment, stability is usually also defined as the ability to recover from failures and imbalances, that is, a given object, process, or system's ability to return to an equilibrium state.

[1] ŠIMÁK, Ladislav. *Crisis management in public administration.* Žilina: University of Žilina, Faculty of security engineering, 2015. 259 pp. ISBN 978-80-554-1165-1.

Example:

Aircraft stability means the ability of an aircraft to maintain the flight mode established by the pilot. If the aircraft had no stability capability, in certain flight modes it could not be piloted, and a security incident would take place – an aircraft crash.

In practice, we talk about the stability of mechanical systems; chemical or thermodynamic processes; the geological stability of subsoil; currency stability; social, political, and economic stability; stability of our financial income; stability of health; etc.[1]

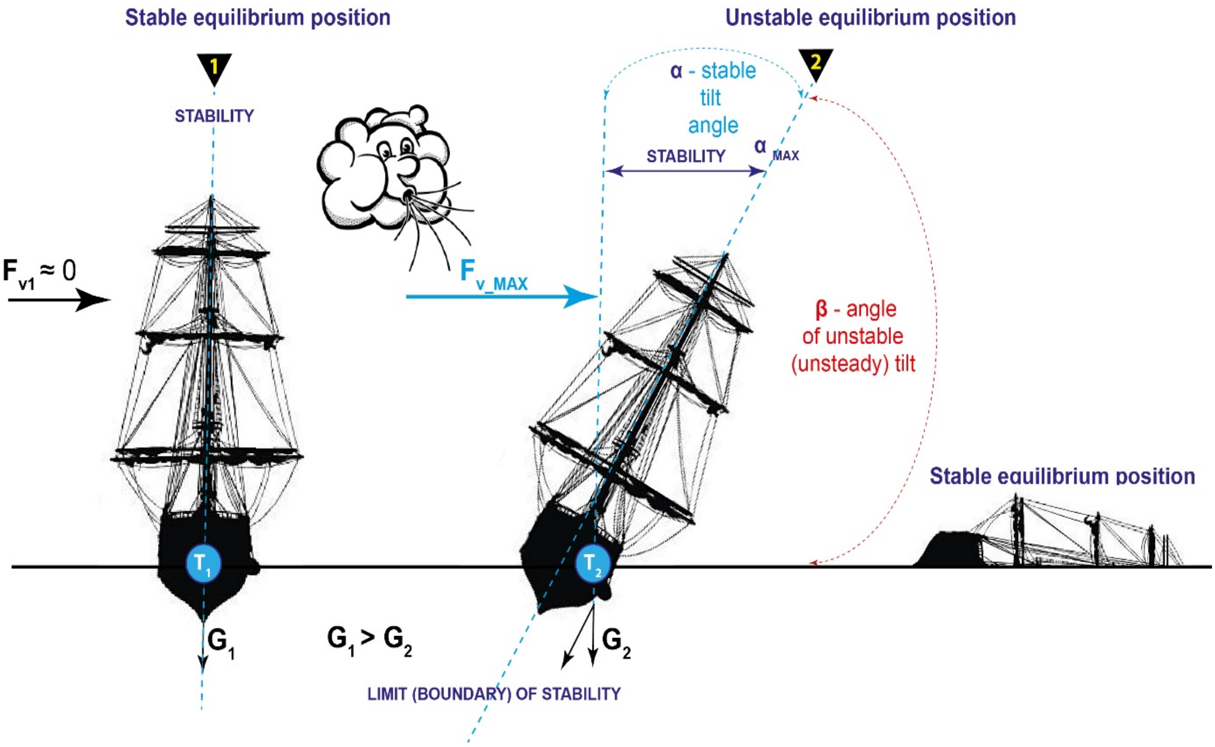

Fig. 4 A sailing ship's loss of stability as an example of the effect of significant external factors on equilibrium and equilibrium position

Example:

Stability can be explained by the example of a sailing ship exposed to a crosswind acting with the force F_v. The significant parameters for the loss of stability of the ship are the crosswind forces, the location of the ship' centre of gravity T (structural design, load fixing), and the ability of the captain and crew to handle the ship.

Under a certain maximum wind force F_{v_MAX} the mast tilts to the angle α. If the cargo the ship is carrying belowdecks is not sufficiently fixed, it will move with the tilting of the ship, meaning the ship's centre of gravity will change its location to T_2. If this angle is $\alpha < \alpha_{MAX}$, and the wind force decreases, the tilt of the sailboat mast will automatically return to its original, vertical, equilibrium position. However, if the wind force increases beyond its limit F_{v_MAX}, the ship will experience instability and will capsize. From this new equilibrium position, the ship will not right itself to its original vertical, stable position. The captain, to prevent his ship keeling over, must take the

[1] MACEK, Pavel a Antonín FILÁK. *Základy teorie policejně bezpečnostní činnosti*. Praha: Police History, 2004, p. 160. ISBN 80-864-7721-5.

following measures: the heaviest cargo must be placed as deeply as possible in the underdecks; in case of a strong crosswind, the boat must be manoeuvred to eliminate the crosswind and turn it into tailwind by changing the position, or f, of the boat; or the sails must be scandalised (rolled up). Strong crosswinds are always a major change in the sailing environment.

The stability of an object, system, or process depends on many of its specific properties, such as resistance, immunity, flexibility, endurance, durability, and the like to certain (normal and explicitly negative) phenomena, events, acting forces, and generally acting factors. At the same time, stability can strongly depend on the nature (size, direction, dynamics, intensity, specificity, etc.) of factors acting on the objects, systems, or processes being monitored.[1] Stability is a relative, elastic equilibrium resistant to some deviation from equilibrium state, equilibrium position.

Every stability has a certain limit, boundary, or duration in the real world, a point where objects, systems, or processes are no longer stable and become unstable (unsteady), with all their negative security aspects and their impacts.[2]

Stability can be a very relative term – some objects, systems, and processes do not change during the life of a single human, while other objects become unstable (unsteady) in a fraction of a second.[3]

In the processes associated with threat, vulnerability, risk, and security analyses[4] [1], we often analyse the properties, characteristics of objects, systems, and processes of interest. For this reason, it is necessary to pay attention to everything, in all contexts, that affects the stability/instability of the object of interest. Usually, our goal is to maintain the maximum stability to avoid potential security phenomena, events, disputes, conflicts, crises[5],[6] etc.

Stability (from the Latin *stabilis* – stable, permanent, fixed) can generally be characterised as a property or ability of an object, system, or process to automatically maintain its stable, essential characteristics, significant parameters, equilibrium state, equilibrium position, equilibrium, integrity, structure, functionality, complexity, or other significant features when faced with deviation from its equilibrium; that is, the ability to

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[1] KOPENCOVÁ, Dagmar; FELCAN, Miroslav; RAK, Roman. *Objects and systems - Basic analytical security features*. Proceedings of the 14th International Symposium of 14. 3. 2019 in international Security expo Bratislava 2019, Academy of Police Corps in Bratislava, Bratislava, pp. 212, ISBN 978-80-8054-795-0, pp. 41-55, 2019.

[2] PORADA, Viktor a kol. *Bezpečnostní vědy*. Plzeň: Vydavatelství a nakladatelství Aleš Čeněk, s.r.o., 2019. 780 pp. ISBN 978-80-7380-758-0. 2019.

[3] SEKYROVÁ, J., KOPENCOVÁ, Dagmar; MANAS, R. *Documentation methods of forensic crime scene.* Czech Ministry of Interior, Prague, MV-39230-1/VO-2010, evidence number 9/2010, 2010.

[4] AUGUSTIN, P., ODLER, R. The mission of the police in a democratic state in the context of globalization. In: *Securitologia: scientific journal, semiannual.* 2013, No. 2., Vol. 18, Nr. 2 pp. 55-64. ISSN 1898-4509.

[5] ŠIMÁK, Ladislav a kol. *Terminology dictionary of crisis management].* Žilina, pp. 36, 2006. ISBN 80-88829-75-5.

[6] ŠIMÁK, Ladislav. *Crisis management in public administration.* Žilina: University of Žilina, Faculty of security engineering, 2015. 259 pp. ISBN 978-80-554-1165-1.

automatically return to an original equilibrium state, position, or equilibrium within some time.

Social stability

Social stability is the equilibrium state of a social system when changes take the form of gradual adaptation to changes in conditions and the environment. Achieving such a state is at the heart of sociology. The various theories of sociology deal with the issue of social stability, for example in thoughts about the optimal relationships among the factors of social statics and social dynamics; applied sociology wishes to contribute to an increase in social stability by solving specific social issues or through engineering interventions in social relationships. The urgency of ensuring social stability often arises in a modern society that has replaced tradition, a highly effective stabilising factor, with the need for continuous innovation. If the social stability of a traditional society had been very close to social stagnation, modern stability often cannot be achieved at the expense of change, but rather through creating the right conditions for regulating changes in course. The issue of social stability,[1] which at a theoretical level does not pose a grave issue, is in fact one of the most serious issues of practical politics. While totalitarian systems often ensure social stability by mortifying civil society, democratic societies largely achieve their social stability through excessive consumption available to the majority of the population.

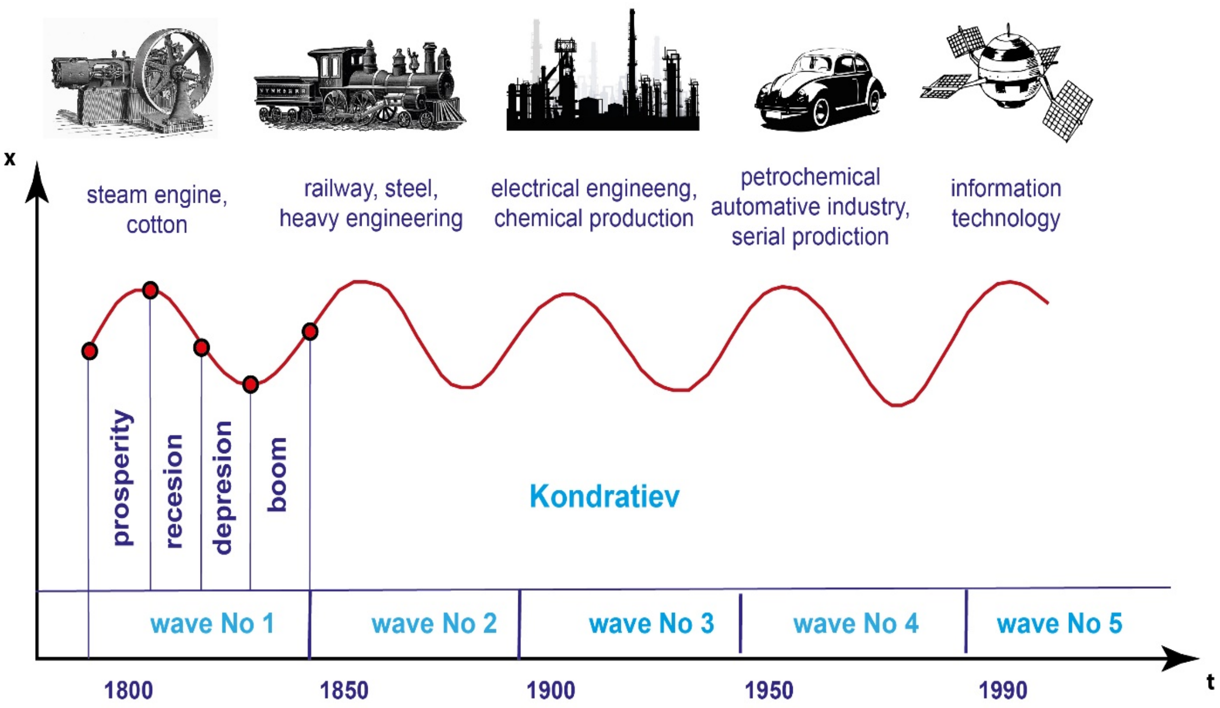

Fig. 5 The world economy develops in business cycles.

[1] JANDOUREK, Jan. *Sociologický slovník*. Ed 1. Praha: Portál, 2001, pp. 128. ISBN 80-7178-535-0.

Economic stability

Economic stability is a state expressing the existence of assumptions under which, after every external disturbance of economic equilibrium, such equilibrium is restored either in its original form or as a new equilibrium. If any great deviation from equilibrium generates forces that return the system to its equilibrium state, we talk about a global stability; in the case of minor deviations, local stability.

The world economy develops in business cycles (see Fig. 5). Periodically, phases of prosperity, recession, depression, and conjuncture change. The Kondratiev cycle takes place, on average, over 50 years. There are more cycles of this kind in the economy, and the author of this overview in particular differs in what he believes explains the causes of prosperity – in the last 200 years, technological inventions prompted the population's demand for new, mass-produced goods. Periods of stability and lability alternate cyclically.

The term economic stability means the steady GDP growth, price stability, and maintaining unemployment at the level of natural unemployment. This means that the product should grow evenly and at such a pace to ensure price stability and sufficient employment.

Financial stability

Financial stability or **financial system stability** is a state of financial markets in an economy that prevents the creation of system risk, that is, the risks of providing necessary financial products and services that disturb the financial system so much that it may significantly affect economic growth and welfare. The origin of potential system risks in a financial system must be handled through macro-scale precautionary policies whose goal is to maintain financial stability.

The Czech National Bank defines financial stability as a situation where the financial system meets its functions without any serious failures or undesirable consequences for both the current and future development of the economy as a whole, and at the same time shows a high degree of resilience to shocks.

Instability as a security risk

Any fact, activity, event, or phenomenon that occurs in nature, society, the economy, technological processes, or elsewhere in a stable manner may, as a rule, become unstable (unsteady), risky, and uncontrollable with the real possibility of causing harm or losses to individuals, groups, institutions, companies, society, or the state. However, if one understands the causes of changes in objects, systems, or ongoing processes, if one is able to detect their symptoms in a timely manner, one may seek ways to eliminate or minimise threats (dangers), develop ways of reducing the risks of security events, avoid crisis phenomena, or eliminate negative phenomena before they affect any objects, systems, or processes. Detecting and continuously monitoring parameters that may become crisis factors for a given situation allows one to avoid negative impacts and to achieve a corresponding level of security.[1]

[1] FELCAN, Miroslav. *Problematika veřejného pořádku jako jedna z nejdůležitějších oblastí veřejné správy*: chapter3 (author Miroslav Felcan: In: Current problems in public

Boundary states

The term ‘marginal state’ is a term behind a concept that may be applied to different entities in various fields of human activities (including security) – to man-made artefacts, to living or non-living ‘products’ of our planet’s evolution, and so on. Generally, the cut-off state is the point in time when an entity (object, process, or system) is severely disrupted, causing the entity to lose its original functionality. Limiting states are applicable to humans; society; products; technical, natural, or social entities; morale etc.[1]

The knowledge of the existence of limiting states is also very important in security[2]. We work with different entities (objects, processes, systems) in risk analysis and countermeasure design processes. Usually, we use standard or transient states of these entities when there are no real threats; entities are in their steady, stable states over the long term. We often do not realise the limiting states of analysed entities until they appear and completely change the entity’s properties, behaviour, and functionality. There is a situation when we cannot ensure security at the required level because the entity has changed fundamentally as a result of its marginal state and has ceased to fulfil its originally intended function or activity.

Limiting states may be divided into categories according to the type of entity in which they occur:[3],[4]

- **Limiting states in technology** occur in technical objects, they are; therefore, the limiting states of technical objects. The reasons for removing a technical object from its function may be subdivided into technical (internal causes; corresponding technical limiting states) and technical-environmental (external causes, corresponding to technical and environmental states).
- **Limiting states of nature** (also ecological, environmental limiting states) occur in natural objects. Ecological limiting states may occur on various scales. They may be local, large-scale, or global. They may be caused by inappropriate human interventions into nature (e.g. amelioration, chemical substance application – fertilisation, preparations against undesirable flora and fauna, construction modifications – dams, motorways, toxic landfills), inappropriate effects of technical objects on nature (emissions, air pollution, soil and water pollution). The cause may also be nature itself – tornadoes, earthquakes, tsunamis, floods; space – collisions with cosmic bodies, etc.

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administration) Kristína Králiková, Mária Sabayová a kol. Bratislava: Akadémia Policajného zboru, 2016, pp. 41-60. ISBN 978-80-8054-712-7.

[1] HENDRYCH, Dušan. (et al.). *Law dictionary*. 3rd issue Praha: Beck, 2009. 459 pp. ISBN 978-80-7400-059-1.

[2] ODLEROVA, M. *Information technology and operative-search activity.* In: Act on police corps: Application on practice. Plzeň: Vydavatelství a nakladatelství Aleš Čeněk, s.r.o., 2017, pp. 196-217. ISBN 978-80-7380-682-8.

[3] VLACH, F. *Evaluation of cooperation between educational institutions of the armed forces.* New trends in police training III. International conference. Holešov: Higher Police School and Secondary Police School of the Ministry of the Interior in Holešov, 2018, pp. 121-124. ISBN 978-80-7616-008-8.

[4] JANÍČEK, P. *System conception of selected fields for technicians. Finding connections*. Vol 1., Brno: VUT, 2007. 682 pp. ISBN 978-80-724-555-6.

- Limiting states of humans (living beings). The object in this case is a person who may be characterised by their material body, intangible mental processes, and interactions with their surroundings, that is, people, artefacts created by them, nature, and the universe. Personality limiting states may be broken down by the causes that cause them, namely:
    - **Intrinsic –** this includes, for example, health limiting states associated with physical and mental illnesses; ethical limiting states that are related to human behaviour in relation to other people, their artefacts, and nature;
    - **Extrinsic –** this includes limiting states associated with the following factors:
        - Retirement;
        - Disagreements at work, in the family, within social or political organisations, sports clubs, other clubs, etc.;
        - Work overload – psychological limiting states, burnout syndrome.
- **Economic limiting states.** In the economic environment, it is possible to find a number of entities (objects, processes, systems) that reach their limiting states under specific conditions; to a greater or lesser extent threatening economic security (of individuals, institutions, firms, banks, insurance companies, leasing companies, individual industries, markets, communities, states). Some of the monitored system variables (parameters) of the economic state include indicators such as debt levels, loans, credits, mortgages, creditworthiness, ability to repay loans, inflation, unemployment, purchasing power, rates of exchange between local and world currencies, productivity, insolvency, secondary insolvency, personal, corporate, state bankruptcy, debt collection, etc.
- **Limiting social, professional (social, professional limiting states).** The most widespread social limiting state is a **revolution**. This is a qualitative limiting state characterised by the fact that a certain social order cannot (or is not wished to) continue to fulfil its function. The stimulus for revolution usually does not come 'from above', from the ruling power groups trying to maintain a status quo. The source of revolutions is a long-term dissatisfaction felt by much of the population; thus the stimulus comes 'from below', from the 'oppressed' who no longer wish to continue in a given way. It is not true that in all the cases must there be a revolution. Dissatisfaction with the current state in democratic societies affects politics, elections to various representative bodies, strikes at various levels, public protests, etc., which are evolutionary processes, not revolutionary ones.
- **Morale limiting states –** this includes, in particular, the state of morale and associated limiting states of terrorism, violent religious expansions, etc.

Breakdown of limiting states per their properties

The number of limiting states of various objects may be quite vast, so we can group them, for example:[1]

- Per the nature of state variable changes
  - **Qualitative limiting states** – a limiting state occurs if the value (quantity) of some of the state parameters becomes inadmissible for the object function.
  - **Quantitative limiting states** – a limiting state occurs if the quality of some of the stated parameters change, that is, if they prevent the object from functioning.
- Per their origin time course
  - **Instant limiting states** – the creation of a limiting state only depends on the instant values of the state parameters, which determine the limiting state origin.
  - **Cumulative limiting states** – the origin of a limiting state depends on the accumulation of changes in the properties of an object's structure in the process of progressively acting and influencing the object from its surroundings. Therefore, it does not depend on the instant values of the parameter of this acting and the influence on it, but on their time course.
- Per the potential sequence of limiting states
  - **Excluding (disjunctive) limiting states** – two limiting states are referred to as 'excluding' if only one of them may arise, making the other non-achievable (i.e. it will not follow);
  - **Causal (subsequent) limiting states** – two limiting states are referred to as causal if the origin of one of the limiting states creates conditions for the potential origin of another limiting state.
- Per the behaviour after object activation removal
  - **Reversible limiting states** – after the removal of an object causing a limiting state, its consequences will subside.
  - **Irreversible limiting states** – the consequences of reaching a limiting state remain after the object activations were removed.
- Per the character of consequences of reaching the limiting state
  - **Disturbance limiting states** – achievement of a limiting state causes a disturbance whereby the object is unable to perform its function, but after the disturbance is removed the object is operational again with its full, original functionality.
  - **Security limiting states** – related to object security. Achieving a limiting state will cause the destruction of a component that is part of a protective device against emergency conditions. The destruction of this 'protective component' protects the object from the emergence of other limiting states.
  - **Emergency limiting states** – related to object emergency. Achieving the limiting state leads to object destruction.

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[1] JANÍČEK, P. *System conception of selected fields for technicians. Finding connections*. Vol 1. Brno: VUT, 2007. 682 pp. ISBN 978-80-724-555-6.

- Per the possibility of their occurrence
- Per the size of the area featuring the limiting state
- Per the statistical concept of limiting states
  - **Deterministic limiting states** – limiting state characteristics (limiting surfaces) and reliability characteristics are unambiguously determined (the quantifier is defined by a single value).
  - **Deterministic limiting states** – limiting state characteristics (limiting surfaces) and reliability characteristics are not unambiguously determined (the parameter is an interval number).
- Per the number of limiting parameters describing a limiting state
  - **Single-parameter limiting states** – limiting condition only contains one limiting parameter (for example, a mortgage non-payment warning will come when a payment is 10 days overdue)
  - **Multi-parameter limiting states** – the limiting condition contains more than one limiting parameter (e.g. water starts boiling at 100 °C and 1 atm pressure).

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R E S U M É

RAK, Roman: FENOMÉN ROVNOVÁHY A MEZNÍCH STAVŮ V BEZPEČNOSTNÍCH VĚDÁCH

Otázka rovnováhy a mezních stavů v systémovém přístupu k řízení bezpečnosti v obecném slova smyslu nebyla v praxi široce využívána, alespoň prozatím. Mezní stavy jsou odborníkům a konstruktérům dobře známy, zejména v oblasti inženýrských činností, ve stavebnictví, ve strojírenství, v energetice, dopravě atd. Znalost mezních stavů však může být ve skutečnosti aplikována na jakýkoli objekt, pokud zvažujeme jeho specifické vlastnosti. Nemusí to být nutně pouze výrobky. Teorie mezních stavů je aplikovatelná také na společenské,[1] přírodní a bezpečnostní vědy.[2],[3] Překonávání mezních stavů je v podstatě ztráta stability (u technických i lidských objektů, procesů a systémů) a v důsledku běžnou příčinou různých mimořádných událostí, nehod nebo, v globálnější perspektivě, různých technických, sociálních nebo přírodních katastrof.

Klíčová slova: Rovnováha, rovnovážný stav, rovnováha sil, stabilita.

S U M M A R Y

The issue of limiting states in a systemic approach to security management in the general sense of the word has not been widely used in practice, at least for the time being. Limiting states are well known to engineers and designers, especially in the fields of civil engineering and other types of engineering, power supplies, transportation, etc. However, the knowledge of limiting states may, in fact, be generally applied to any object, providing we consider its specific characteristics. It does not have to be necessarily only products. The theory of limiting states is applicable to social,[4] natural, and security sciences as well.[5] Overcoming limiting states, in essence, the loss of stability (in both technical and human objects, processes, and systems), is a common cause of various emergencies, accidents, or, in a more global perspective,[6] diverse technical, social, or natural disasters.

Keywords: Equilibrium, equilibrium position, balance of forces, stability.

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