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OPEN PROBLEMS IN PROTECTION OF LIFE-GIVING INFRASTRUCTURES AND SUPPLY CHAINS

Modern human being depends on the good work of life-giving infrastructures and supply chains. To ensure the safety of such critical infrastructures and the supply chains it is necessary to determine, introduce and keep appropriate level of protection and countermeasures against real risks. Based on the concept of safe community there are followed couplings created in the human system by live-giving infrastructures and supply chains. The assessment of harms caused by their failures and level of management of these failures reveals open problems in followed domains and these were used for formulation of requirements for future research.

Keywords: *Security; Safety; Live-Giving Infrastructures; Critical Supply Chains; Failure; Requirements for Future Research.*

Introduction

The present time characteristics consists in note that: demands of humans on life quality increase; it increases the human vulnerability connected with number of humans and with human dependence on new technologies; it is lack of resources in densely populated areas; and new way of management "JUST IN TIME" limited stocks and reserves and introduces the dependence on early supplies and early services. The security, economic prosperity, and social well-being of humans depend on the safe and reliable functioning the increasingly complex and interdependent infrastructures that make up the system of systems - hereafter "SoS" [1]. Highly efficient, complex, and interdependent infrastructure systems including the electric power, telecommunications, transportation, water utilities, food distribution, housing and shelter, public health, finance, banking and public governance are the foundations of modern societies. In the new economy, these interconnected infrastructures have become increasingly fragile and subject to disruptions that can have broad regional, national, and global consequences.

The paper summarizes the results of assessment of failures of live-giving (vital) infrastructures and of level of management of these failures in the Europe, special attention is paid to failures of supply chains, and also to the finance infrastructure the failure of which caused present finance crisis in the Europe.

1. Nature of live-giving infrastructures and supply chains

Infrastructures assure quality of human life, enables humans´ protection and their survival in critical situations. They represent large technological facilities, the technological systems, which are more than just a set of technical equipment parts and components. They reflect the organizational structure, management, operating rules and culture of design organizations that created them and are usually also reflections of the society in which they were created (see [2-4]). Accidents are often blamed on operator error or equipment, without distinction of industrial, organizational and managerial factors that caused the errors and shortcomings in question to become unavoidable. The causes of accidents are often, if not almost always, rooted in the organization - in its culture, management and structure. All these factors are critical to the safety of technical systems. Analysis of the causes of past accidents shows that the issue is very complicated and its solution requires a high professional perspective and genuine desire to solve problems, both in the management and in the engineering disciplines [4].

In terms of exact sciences, each technology subsystem consists of the controlled object and the control system. The controlled object is usually a complex nonlinear system: it consists of numerous elements, where each one is uniquely described by a finite number of measurable variables. Interactions between elements are clearly formulated. Dynamic properties of the controlled object can be described by differential equations, the solution of which is the state vector. The state vector allows determining the state of the system at any point in time using the minimum number of variables. The control system must maintain specified physical quantities at predetermined values. In the process of regulation, the control system changes the state of technological system by affecting the action variables in order to achieve desired state. When managing the control system (according to the recent concept that places the highest emphasis on safety) the priority order of features

such as: safety (level of compliance with the conditions of operation and non-creation of harmful (unacceptable) impacts on the system itself and its surroundings); functionality (level of performance in execution of required acts); operability (level of performance in execution of required actions depending on normal, abnormal and critical conditions); operational stability (level of compliance with the conditions of operation at time); and inherently built-in resilience to possible disasters [5].

1.1. Specific properties of banking sector and its failure

The form of money gave to many natural and human creations common, quantifiable value. This has tremendously facilitated trade and mainly contributed to the development of economy and prosperity. ***The basic function of money*** in the economy is: the money as a ***medium of exchange.*** Especially precious metals (gold, silver), which were later transformed into coins (currency), have been shown to be the most appropriate to express the value of anything. Today, there are two forms of money as the basic medium of exchange. This is the ***form of cash and non-cash***, e.g. payments over current accounts of banks. In fact, you can convert any cash you deposit in bank accounts to non-cash resources and of course vice versa. Both forms of money are emitted in a similar way, in principle, these are the bank loans. The fundamental difference is that ***only the central bank,*** with certain exceptions, ***can emit cash money***, as a financial loan.

Money allows the transaction in the economy. If its number does not grow sufficiently, the number of transactions is limited and therefore in fact the economic growth. (Otherwise, of course, inflation will be the opposite, and there is the main role of the central bank). Therefore, the growth of the money should correspond to the healthy growth of the GDP. The bank crisis in the banking system is characterized by a lack of liquidity of larger amount of banks. This situation may lead to massive bank failures.

Based on the analysis of the data in [6] the main causes of banking crises are: the macroeconomic development; poor management; criminal activity (i.e. tunneling); and lax banking supervision (though it is not the primary cause). Secondary causes of banking crises are: inefficient activities of banks; redundant number of workers; shareholders pressure to obtain more advantageous conditions; insufficient accountancy of banks or clients; and improvement of results.

The consequence is a lot of impacts on humans and public assets, especially the decline in economic activity, consisting in a credit contraction (credit crunch), which reduces the availability of credit. The result is bankruptcy of otherwise viable businesses, and it has an impact on: the fall in GDP growth; and an absolute decline in GDP eventually. The financial crisis in the banking sector may be in the first level of classification divided into two main factors of their formation: the financial crisis in the banking sector resulting from entrepreneurial activities, i.e. as a result of implementation of banking risks, which include: credit risk, market risk, liquidity risk and business risk; and the financial crisis in the banking sector resulting from the occurrence of adverse events of all kinds [7], i.e. the implementation of operational risks.

In practice, it is necessary to consider also systemic risk. To the understanding of this risk it is important to remember the chain of events that can start realizations of any of the five above-mentioned risks. Their realization (individually or in combination) causes the bank many problems that have an unacceptable impact on many other subjects and in extreme cases even on the greater part of the financial system. Systemic risk is essentially the risk of transmission problems, the inability of one institution to meet its obligations will cause that other institutions will not be able to meet their own obligations. The relevant failure may cause significant liquidity problems and difficulties in repaying loans to banks and, consequently, may threaten the stability of the banking system as a whole. Protection against systemic risk is a part of the activities of regulators of financial markets (including the institutions of the banking supervision) and central banks.

It follows from above-mentioned that the banking sector and any other financial sector is a complex system.

Security and sustainability of human society depends on the level of integral safety management, which ensures public assets, to which belongs the critical infrastructure, the part of which includes is banking and financial sector. By the expert survey with the participation of 62 specialists in the field of civil protection, there were, by specific modification of methods What, if [2,9], identified the impacts of long-term failure of the banking sector and financial sector, which reveal severity of such failure (Annex 1).

1.2. Specific properties of supply chains and their risks

The human system like any other system is described by the basic elements (assets), links among elements (physical - material, territorial, cyber, logical) and flows that make more or less important couplings, which in some cases fundamentally determine the behavior of human system [2]. With regard to the uneven spread of humans and unequal distribution of food and other resources, quality the supply chain is highly significant for the human life. Events in recent years as the interruption of oil supplies to Central and Western Europe due to disagreements between Ukraine and the

Russian Federation have shown high vulnerability of selected commodities and they led to the opening of the new problem that the EU must solve for its security and development. The present research specifies some security problems of supply chains.

The supply chains are multistage systems that are comprised of suppliers, manufacturers, distributors, retailers and customers and in where among the individual levels in both directions there run flows of materials, finances, information and decision. Material flows include flows of raw materials, intermediate products and finished products away from suppliers to customers. Conversely, there are oriented flows of products for repair, recycling or disposal. Financial flows include various types of payments, loans, cash flows arising from the ownership, etc. Information flows linking the system by information about orders, supplies, plans, etc. The decision flows are sequences of decisions of participants affecting the overall performance of the chain, i.e. among the final contractor and all its sub-contractors who are involved in the completion and delivery of supply according to the contract between final supplier and customer of delivery. The supply chain can contain more levels of co-operation stages and it always relates to the performance of one supply. Mutual relations among the co-operative stages are based on a contractual basis.

The supply chain includes all transport and activities related to transport and procedures, starting from the production plant and ending at the cargo destination, i.e. it is a network of autonomous or semiautonomous business entities collectively responsible for procurement, production and distribution activities associated with one or more related manufacturers.

The theory of supply chain involves the planning, implementation and control of operations applied to the supply chain as efficiently as possible. Supply chain management encompasses all the movement and storage of raw materials, inventory and movement of finished goods from the point of origin to the point of consumption. In the theory and in management there is used a specific term “outsourcing” [10]. Outsourcing is the division of labour, the purchase of semi-finished products, financial loans and almost all other activities at the store. All the outsourcing issue is contained in the problem of deciding whether to "make or buy" (make vs. buy) or "to own or rent" (own versus lease). In the domain of information sharing there is one of the many questions raised when considering the possibilities of outsourcing, the question of safety. The safety can be further divided into two categories. One is data security, i.e. ensuring data from loss (backup). The second category is to protect data against unauthorized abuse, i.e. defence against intrusion into the system and transfer the information stored in the information system to third parties by employees.

It is a question who and how ensures that the information stored in the system will not be abused by the company that governs (administrates) the system. A possible answer is the look into statistics, but it is necessary to consider that the amount of penalties that company may apply to the company's own employees (insiders) is as a rule lower than possible financial penalty of an outsourcing company. The security aspect is managed by a contract in which this domain may be a part of the contract on outsourcing or it may be included in a separate agreement on confidentiality.

The Supply Chain Management (SCM) is turbulently evolving discipline that uses concepts that were developed in various other disciplines such as logistics, marketing, financial and operational management, information systems, economics, dynamics of systems and operational research. Quality of governance (management) of the supply chain is considered as the key to its future competitiveness, and therefore, it raises considerable interest of managers and researchers. Modeling the supply chain is a frequent topic of conferences and professional communication.

Supply chain management deals with the mutual relationships among supply chain components, i.e. among suppliers, carriers, customers, vendors, managers for waste management, including those who engage in products after the end of their lifespan. These interactions are likely to change in the chain up and down depending on what the subject of interest of an organization in the supply chain. It is clear that effective communication can strengthen co-operation, reduce the potential for misunderstanding and influence the measures taken by organizations in the supply chain.

In modern operating company it is necessary that the company management may be capable to manage the supply chain very efficiently. An important component of these chains is an understanding to subcontracting or also to outsourcing domain, which is used by almost every company today. Firms must know which activities should be delegated to external institutions specialized in the implementation of these operations. Optimal decision on what operations and to what extent delegate, leads to reduction of costs or to the possibility to focus on more important tasks related to the firm competitiveness.

Every company is trying to assert itself on the market, defines its mission, so called the company mission. From this mission targets are determined, i.e. objectives, which the company may achieve in a particular market in a certain timeframe. Based on these stated objectives there is then formed a corporate strategy, i.e. the determination of the procedure, the means and methods how to meet those objectives. Together with this, it originates the question of the necessity of "correction" of strategy outlined or its new creation, with the

view of changing the scope of the dominant factors affecting both inside and outside the company. In most cases, there are just vicinity factors, which are the main cause of the prosperity or decline of the company.

Enterprises are increasingly confronted with global competition, which is caused by increasingly demanding customers. In order to succeed, they try to control the efficiency of their operations that create and provide products to the attention of end users within the supply chain. In recent years, supply chain management is becoming important for firms as a competitive advantage. Fierce competition in today's global markets, marketing of products with shorter life cycles, rising customer expectations, forcing companies to focus their attention on the supply chain influence the situation.

The aim of supply chains´ management is to ensure the safety of all participants of supply chains to which it belongs: participants´ prosperity; fulfillment of tasks for which they were established; harmony with state on which territory they perform the activities [2]. There are two broad categories of risk that must be controlled in case of supply chain: the risk that is the cause of the lack of the co-ordination of requirements and supply; and the risks associated with failure of normal operation, which is caused by disasters of all kinds, i.e. natural disasters, technological accidents, terrorist attacks, power failures, strikes, etc. According to analysis in [11] there are particularly important strategic risks, financial risks, operational risks and risks associated with threats followed according to the approach pursued by the All Hazard Approach [7]. According to ISO 28000:2010 [12] the major damages in supply chains cause: physical failure (e.g. failure of the equipment, intentional physical damage); operational failure (technique failure, human error); natural disasters (e.g. floods, storms); external threats (e.g. failure of outsourced activities or externally ensured activities); and threats from the interested parties (e.g. State - failure of comply with legal and other regulations).

According to the EU documents, followed in [13], the supply chain must follow the following subcategories of risk: construction and design and technological risks; credit risks, market risks, external risks, operational risks, and risks associated with the management and decision-making. Analysis and evaluation of these risks are required when applying for European Union's projects [14]. Construction, technological and design risks include: construction and design risk; site risks, and the risk of erroneous technologies, networks and related services. Construction and design risks that include the risk associated with the design documentation (good / bad, error); risk connected with construction; risk connected with exceed of construction costs; risk connected with pollution of site / site vicinity during the project realization which is caused by public administration; risk connected with pollution of locality / neighborhood during project, which is caused by the supplier; the risk associated with the impact of the project on the environment during the project life that is caused by bad decisions of public administration; and risks connected with the project impact on the environment during the project life that cause contractor and operator). The risk of a given site includes the risk associated with the current object; risk associated with the availability of site; risk associated with ownership of the site; risk associated with the state of a site; risk associated with networks (utilities) located on the site (construction site); risk associated with the land-use plan; risk associated with a construction permit; risk associated with cultural / archaeological heritage; and risk associated with the protected landscape area. The risks associated with faulty technologies, networks and related services include: risks associated with a defect during the implementation of the project; risk associated with a defect in the lifetime of the project; risks associated with using the wrong technology; risks associated with technological insufficiency; the risk associated with an unexpected disruption of power supply, loss of services and support systems provided by the private sector; and risk associated with an unexpected disruption of energy supply, loss of services and support systems provided by public administration. Credit risks include: liquidity risk; and risk of default / i.e. the availability risk, which is further divided into: risk associated with availability (default by the private sector); risk associated with failure of counterparty and with the loss for public administration; risk associated with the failure of the counterparty and loss for the supplier'; risk associated with the concentration (for all deliveries there is only one supplier); and risk associated with rejection of partnerships (public administration does not support the project). Market risks include: demand risk in case that the contractor is a public administration; demand risk if the supplier is a private entity; the risk that benefit is for rival; and other market risks such as: currency risk; inflation risk; and interest rate risk. External risks include: political risks; force majeure; and other external risks. Political risk includes: risk associated with national or international situation; risk of government default; and supranational political risk associated with duties of the state in the EU and NATO. The risk associated with force majeure includes: risk associated with natural disaster with the size of catastrophe; risk associated with terrorism; and the risk associated with war. The item "other external risks" includes: the risk of legal / tax general nature associated with changes in legislation / taxes; risk of legal / tax specific nature; the risk associated with the need for additional authorizations; and risk associated with the situation in the sector (strikes). Operational risks include: risks related to

the equipment; the risks associated with people; and risks associated with human negotiation. Risks associated with the device include: the risk associated with the device inputs (material); risk associated with maintenance, repairs, modifications and adaptations; and the risk associated with small amortized cost. Risks associated with humans include: risks associated with inadequate labour; risk associated with non-replaceability; risk of scarce human resources; risk associated with labour-legal disputes; and risk associated with human error. Risks associated with the human negotiation include: risks associated with fraudulent negotiations; risk associated with illegal negotiation; risk associated with safety of technological systems; and risk associated with derogation and theft.

Risks associated with the management and decision-making include: contractual risks and other risks associated with management and decision-making. Contractual risks include: risks associated with the responsibility to third parties; risks associated with the change of contract; and the risk associated with the violation of generally binding regulations. Other risks associated with the governance and decision-making include: risks associated with strategic decision; and the risk associated with reputation. The definitions of partial risks in the financial sectors are given in [14].

The risks of supply chains according to work [11,15] provides the following phenomena: traditional property risks - fires, natural disasters, power system outages and downtime device; theft, violence and terrorism; political instability and risks, fluctuations in exchange rates, supply interruptions due to political problems in the country of the supplier; fraud and some consequences of central planning economies; failures of computer and telecommunication networks; very demanding customers requiring fast and precise delivery; short product life cycles as a result of the diversity of products, their substitutability and emphasis on their continuous innovation and flexibility; complete conformity of the products according to the laws of individual countries; and failures in communication with suppliers. The risks associated with supply chains are very serious, and therefore, they are the subject of current research and investigations [16]. The overall objective of the risk management of the supply chain is to identify current sources of risk in supply chains, to perform distribution of risks according to the size of damage that can cause their implementation, and to find suitable trade-off with risks so that the operational organizations may be safe and no adverse impacts on public interests may occur.

Based on documented statistics [16] among the five most frequent risks to the supply chain it belongs: failure of suppliers; production interruption; logistical difficulties; IT failures; and rising prices of oil and energy. These risks are predictable, their trade-off is essential for a safe organization, and hence, the organizations engage critical attention to their management.

International supply chain has many actors and it covers a huge amount of goods. Vulnerability is double: on the one hand there is a large risk of failure origination due to a terrorist attack, and on the other the goods are used as means of an attack. At the same time there is vulnerable the economy of countries, which directly depends on the reliability of the supply chain. International supply chain also suffers from the consequences of abduction [17]. Therefore, internationally and within the EU there are extensive programs for the protection of the international supply chain, especially transport shipment, sea freight, air, rail and automotive [17]. Important role in the international scale of safety plays a non-profit organization TAPA (TheTransportedAsset-ProtectionAssociation) that was founded in 1997 in the USA, in Europe it started activity in 1999 and Asia in 2000.

In practice it holds the generic standard for the management of security systems, ISO 16125, which deals with security systems related to all forms of threats to the organization by fraudulent, malicious, dishonest or intentionally negligent individuals or entire organizations. To ensure safety it means to establish, implement and maintain an adequate level of protection and measures against such threats. The purpose of the document is to provide a security team of organization the systematic approach and guide for the assessment and management of security risks with target to reach an overall safety of the operation of organization and other stakeholders.

Detailed guidance annexed to this standard, states that threats are specific to different sectors, and it gives their solutions in line "with good practice" that can be taken in the security policies, procedures, infrastructure, systems and tasks in order that it may be possible to face individual risks. Generic document builds on existing ISO standards relating to safety and it adds them, as e.g. standards that specifically deal with information, information technology, intellectual property and the safety of supply chains [18].

Logistics of supply chain is based on information sharing between enterprises based on electronic technologies with reality that the technologies used and their applications are different. From a technological standpoint, there are systems of Supply Chain Management - Supply Chain Management (SCM) based on standard principles characteristic for the implementation of relations company with company, a Business-to-Business (B2B), i.e. on electronic data interchange (Electronic Data Interchange - EDI), applications based on XML technology and standards (eXtensibleMarkupLanguage) and on web applications. Functionality for APS (AdvancedPlanning and Scheduling) is based on transactional

applications (e.g. ERP-type - EnterpriseResourcePlanning), possibly in combination with applications and tools for business intelligence. Under the term APS it is understood a system ensuring the production planning with considering all sorts of the restrictions of the production system, such as material, labour capacities etc.

Support for supply chains in the EU focuses on support of the so called intermodal transport logistics, which is a key element of European transport policy. It aims to create a technical, legal and economic framework conditions and innovative concepts for the optimal integration of different modes for services provided by the way "door to door." In particular it goes on ensuring in order that there may be in the transport chain integrated those modes that are more environmentally friendly, such as rail, inland waterways and maritime transport for short distances. The EU adopted a number of regulations and directives in order to create a single European transport market. The legal basis for this a Title V of the EC Treaty, in particular Article 71 (Treaty of Lisbon: Title VI, particularly Article 91 of the Treaty on European Union).

Supply chain according to standard [19] includes all interconnected components of delivery process, starting from collecting the raw materials and ending with delivery of product to consumers (end users). The low professional level within the EU is highlighted in the work [20] according to which it is necessary "to improve co-operation and communication between Member States on a multidisciplinary approach. In this area it will be necessary to create a set of equivalent methodologies for the evaluation of safety and vulnerability in specific areas. "

The work [21] shows that in the EU countries, in terms of global risk there is paid an insufficient attention to threats for the food chain, into which drinking water belongs. According to experiences it is necessary at supply chain management to pay attention to organized crime, which in recent years has become an economic threat. In the theoretical considerations there is necessary a global perspective and in practice is necessary to pay attention to the protection of insured partners along the whole chain, because the insurance is one of the basic tools for the trade-off with risks [14]. Present style of management called "Just in time" [2] facilitates the situation to enterprisers and businessmen on one side – they do not take care on reserve resources, however, on the other it causes the strong dependence on early perfect supply chains.

2. Conditions for stability of a complex system

In the work [22] there is shown the analysis and categorization of systems. Special attention is paid to complex systems, which are characterized by disorganized complexity and are composed to perform certain functions. It is shown that the predictable behaviour of these systems can be expected only, if the system is in steady (stationary) state or near to it. For a system located "near balanced" state, there are typical linear relations, in which flows in the system are linear functions of the affecting forces. ***As a result of nonlinear linkages the behaviour of the system can become chaotic***, that never stabilizes in an even pace and is never repeated in predictable way. The outputs of linear operations change continuously and smoothly with changing their inputs, and therefore, linear phenomena can be modelled accurately; the effect of feedbacks. Nonlinear processes react contrary, i.e. they respond to very small inputs in a discontinuous and unpredictable way.

Sometimes the present context refers to so-called butterfly effect, which leads to the fact that errors and inaccuracies are multiplied, it forms a cascade of turbulent phenomena (turbulence means disorder, instability, vorticity). For a description of system behavior it is not enough to sum up local behavior of elements (or subsystems), but it required a holistic approach, which sees the system as a whole. That means to leave the premise of locality of phenomena, which is based on statement that a major impact have the phenomena occurring in the immediate vicinity of space and time, and vice versa it is necessary to ***accept no locality and interdependence of phenomena.*** In short, "if a butterfly stirs up the air in Beijing, it can change the storms system in New York next month" [23]. According to dr. Gleick [23], the econometric models due to butterfly effect often proved to be blind to what the future brought, yet people who should know it, behaved as if they fully believed in its results. For example prognosis of economic growth or unemployment were and are presented with a natural precision of two or three decimal places, governments and financial institutions for such predictions paid and pay, followed and follow them, either from necessity or lack of something better [23]. Looking at the current situation from this perspective, we can say that the financial crisis in the U.S. and in the EU since 2008 is one of evidence of that statement.

3. Data and methods of specialized research

For investigation of infrastructure and supply chain failures and of their management there were used published original data, e.g. on blackouts in the US, Italy, Switzerland, Czech Republic, disruption of oil and gas from Russia to the Central and Western Europe [24] and simulation of failures of networks creating the basic part of infrastructures [1]. The outputs described in the next paragraphs were created by the pure scientific

methods, i.e. analysis and synthesis of obtained published results on disasters; specific investigation of disasters by analytical and heuristic methods. Heuristic methods were in the first tested on real data if they are suitable for security tasks solution; specific investigation of level of disaster management by help of special questionnaire; and specific investigation for identification of critical items in territory management from the viewpoint human survival performed by special logical tool specially tailored for the FOCUS targets [9].

The detailed study on failures and failures´ management in the EU [11] was concentrated to ten domains the outputs of which are concisely summarized in papers [8, 11, 25-26]. The work [11] also obtains results of theoretical study dealing with the form of EU security concept: it must be based on the systemic (holistic) thinking, the typical feature of which is the focusing on the whole views at systems and on research of relations among their individual parts; proactive approach; all hazard approach [7]; respecting the co-existence of overlapping systems [22]. For its realization there is necessary sophistically managing the failures that damaged the security of community and its assets, i.e. to apply measures and activities of prevention, preparedness, response and renovation. For practical purposes there are necessary good technical solutions based on recent findings and experiences and correctly aimed governance of public affairs supported by legislative with sufficient legal force, finances, qualified human personnel and material base.

4. Deficits revealed in management of protection of life giving infrastructures and supply chains

The results of study of level of management of infrastructures´ and supply chains´ failures are summarized in Table 1.

Table 1

Deficits at failures´ management
from the viewpoint of safe community concept [11]

SECURITY ITEMS	**RESEARCH RESULTS**
Security challenges that can be considered to have big impact in the 2035 time frame and currently are not sufficiently addressed in the planning of research	1. The list of followed disasters is necessary to supplement by: 2. Disuse of research infrastructure. 3. Disuse of educational infrastructure. 4. Disuse of social infrastructure. 5. Disuse of supply chains for terrorist attack. 6. Disuse of supply chain as political attack.
Most severe security challenges that should be addressed by research planning in the 2035 time frame	The disaster order with regard to the impact severity is: 1. Mid-term failure of social infrastructure (disintegration of human society into intolerant groups). 2. Failure of public administration infrastructure due to corruption, disuse of power and non-respecting the public interests. 3. Long-term outage of electrical infrastructure. 4. Long-term stoppage of drinking water supply. 5. Long-term shortage of basic food.
Challenges for future security research for prevention, preparedness, response and renovation	It is necessary to establish norms and standards for infrastructures that will: ensure their sufficient capacities; enhance their robustness and resiliency. To create effective a system for response, especially in case of failure of finance infrastructure and in case of failures of critical supply chains. To create system for renovation (recovery) after critical infrastructures´ failures.
Related main vulnerabilities to be addressed for future security research	The massive collapse of the financial market. Long-term outage of electric energy supply. Long-term stoppage of drinking water supply. Long-term shortage of food supply. Long term failure of critical supply chains. Lack of technical resources, inadequate knowledge and training of managerial staff, poor response management and lack of finances.

Table 1 (end)

Related main knowledge gaps to be addressed for future security research	Methods used are based on deterministic and stochastic approaches and on the assumption that each system is steadily in steady (stationary) state or near it, which is not always true. Into practice it is necessary to include non-linear thinking and way of live with risks connected with interdependences. E. g. lessons learned from Fukushima accident [22] shows that it is necessary to improve the methods associated with the determination of terms of references for design, construction and operation of technological buildings, equipment's and infrastructures. The effective strategy for robustness and resilience of critical supply chains.
Proposed type of future security research	System of management of territory, objects, sectors, infrastructures and chains of critical resources, goods and needs. Integral risk management – because procedures applied so far do not consider cross-cutting risks, which are the cause of cascading failures of complex systems. Respect for public interest and principles for integral safety management.
Expected most needed topics of future security research	Strategic, proactive and systemic management of territories, sectors, infrastructures and chains that respects public interest and principles for integral safety management.

Conclusion

Current practice requirements require in order that each system may be safe under all conditions, not only to themselves but also for their surrounding (i.e. they do not endanger their surrounding by their failure). Therefore, it is necessary to base their management on current knowledge, see for example the application of the theory of possibilities in practice [22], and especially complies with the principles of good management (governance), which except the responsibility and respecting the public interest, includes early recognition of emerging risks and timely application of corrective measures and actions. To ensure the safety in both domains, the critical infrastructure and the supply chains it is necessary to determine, introduce and keep appropriate level of protection and countermeasures against real risks.

Among the important supply chains there belong: Food Chain; and the plan of the necessary supplies, and therefore, in the EU and the CR a considerable attention should be paid their safety. Generally speaking, in the EU the issues associated with supply chains are not completely solved and it is necessary to do their principal modification.

Annex 1 - Impacts of failure of the banking and financial sector to public assets

1. Possible impacts on the lives and health of humans: loss of access to finance and thus buying food, and generally to meet basic human needs; loss of lighting, heating, food preparation options, and leases due to non-payment; due to lack of finance for the care of people, spa treatment, care for the disabled, mentally ill will fail; it will reduce the level of care available to the public; due to lack of finance health care institutions will carry out only urgent cases, it will reduce standards of hygiene, There will not be money for petrol vehicles to rescue workers; from the lack of hygiene and other serious deficiencies people will progressively get ill and epidemics will appear; nursing and rehabilitation services will be stopped; Mental health of inhabitants will be affected by a feeling of hopelessness (saved money in the bank loses all value and savings come to nothing); there will be bulk buying of food and profiteering; people will not get loans for basic food due to the inability to repay the debt and inability to pay wages etc.

2. Possible impacts on the human security: the emergence of panic, chaos, loss of sense of security of the population, fear of the overall development of situation can lead to aggression and panic of people; social riots; feeling of fear, danger, insecurity, depression in case of loss of funds; increase of criminality – also ordinary people will commit crimes, if they are hungry; disregard of prohibitions, commands and laws at all; emergence of barter (exchange of goods) related to the emergence of the black market, etc.; dependence on aid from abroad; distrust of citizens in the state - "taking problem / governance into their own hands"; bribery (not money, it has no value); looting; criminal acts; the emergence of the mafia; work demotivation, lack of money for drugs, etc.

3. Possible impacts on the property: the impossibility of supervision and control of property in electronic form and its management; loss of access to information relating to money, currency and capital; impossibility of property increase, loss of property related to the necessity of obtaining money (e.g. sale of internal furnishings, heritage, jewellery), seizure of property as a result of non-payment by the deadline, and the loss of domestic and breeding animals (first of all people will have to meet their own particular needs and will not have financial resources for animal feed); threatening the property by increasing of looting, thefts, etc.; companies will not have the financial resources for the protection and security of property; gradual devaluation of the property - people will not be able to take a mortgage on the reconstruction or building a new housing, etc.

4. Possible impacts on public welfare: ending of social and cultural events; massive dismissal of state employees (e.g. salaries of officials encumber financial resources, their services will lose the importance, it will not be needed and will not be used during prolonged failure of the financial sector);problems to keep emergency services workers (medical institutions, firefighters, police, army); unemployment of the banking sector employees; ending the trading and services to citizens; not keeping the promises due to financial problems; decline of the economic standards of population; slowdown in social development, failure of public transport; closure of those parts of the infrastructure that will not have a priority (e.g. nursery schools), the operation of those drains the state financial resources; depreciation of food that no one will be able to buy; cafes, restaurants, pubs, bars - the existential problems; all leisure services (swimming pool, sauna, tanning salons, fitness centres, hairdressers, cosmetics, massages, pedicures) will not be used; restriction of tourism, lack of funds to buy tickets; impossibility to repay the debts among citizens → revenges, violence, thefts, etc.

5. Possible impacts on the environment: suspension of ecological activities in the long term dependent on financial resources; financial problems in solving acute large environmental disasters; people will meet the basic needs and there will be no money for e.g. refuse collection (with this relates the increase in the amount of illegal dumps); companies will try to keep a basic production at least, therefore they will save money on e.g. sewage disposal plants, separators, i.e., that will increase the heat and liquid emissions; companies will not have enough money for research of new systems protecting the environment; suspension the construction and operation of sewage disposal plants and other various devices for environmental protection; there will not be money for coal, natural gas → people will burn the garbage what will pollute the air; there will be no money for planting new trees; there will not be any garbage trucks, sweepers will not clean up the streets (mess everywhere); inability to finance various sewage disposal plants, waste separators, cooling devices, etc.; environmental disasters as a result of human inactivity; water pollution due to sewage disposal plants inactivity; environmental damage due to easier access to natural resources; loss of sponsors' financial assets to improve the environment, etc.

6. Possible impacts on infrastructures and technologies, which are further divided into:

- possible impacts on energy supplies (electricity, heat, gas): loss of function of supplies related to financial resources, failure of cyber infrastructure action and other systems that are dependent on electric power; failure of central supplies of natural gas and oil to the state (inability of the state to pay for supplies); reduction of energy supply to households, companies, etc.
- possible impacts on water supply system: loss of function of water supplies related to financial resources; loss of network management in the time, etc.
- possible impacts on the sewerage system: small and reduced functionality and meeting the needs of the population as a result of the insolvency, etc.
- possible impacts on the transportation network: increase of the number of accidents due to failure of poorly paid control signaling; the quality of roads in the winter will be very limited - road builders will not have money to grit and operate the machines; the gradual disintegration of transportation network; considerable reduction and the total collapse of public transport, the Czech Railways, bus routes, passenger and freight transport (lack of money to buy diesel, gasoline and vehicle repair raising of transport prices, etc.
- possible impacts on the cyber infrastructure (communication and information networks); due to nonpayment of services there will be cascading effects and ripple effects in the systems and networks, the collapse of telecommunication network, Internet failures; reduction of the range of radio and television news, magazines, operation of information systems, etc.
- possible impact on the banking and financial sector: the failure of ATM machines and e-banks; internet banking collapse, loss of overview of the situation on the financial market; financial market losses as a result of sanctions for the failure of the transaction and a missed opportunities; Banks will stop the emission of money and giving loans; CNB in the Czech Republic will not be able to control the money in circulation, the amount of money rates and other payment transactions with other countries; there will be a devaluation of money in banks, the loss of purchasing power of money; increase in inflation, hyperinflation; exchange rate decline, lack of money in circulation; stopping imports and exports; loss of carriers, service sectors (especially

of those that offer premium services); the stock market crash,

the inability of employers to pay wages; restriction of social benefits; non-payment of pensions, wages and salaries and thus stopping the works depending on the payments, both at home and abroad; The domino effect because of the lack of information in the banking sector; losses in the financial market as a result of sanctions for the failure of the transaction and a missed opportunity; penalties for late payment due to inability to pay on time; financial losses of bank creditors; the raising prices of goods; the rise of the underground economy; impoverishment ; impossibility of obligations repayment (secondary insolvency, inability to pay mortgages, leases, etc.), inability to dispose of the money in the bank; inability to pay invoices; collapse of trade, etc.

- possible impacts on emergency services (police, fire-fighters, medics: due to problems in financial markets are the activities of police, fire brigade, army limited and activities of hospitals enforced by law (lack of fuel for vehicles of emergency services etc.; more difficult work of medical facilities etc.
- possible impacts on basic services in the area (food supply, waste disposal, social services, funeral services), industry and agriculture: there will be a reduction in supply, postal services limitations, reductions in care services, the total disruption of delivery of goods; restaurants and canteens which will not be able to pay for the supplies will be closed etc.

Possible impacts on state administration and local government: the inability to fulfill all the tasks arising from the responsibilities set by law; inability to keep the situation under control; people will not be able to pay social and health insurance and therefore the State will not have the funds to guarantee these services; failure of schools, retardation of science and research, etc.

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ВІДКРИТІ ПРОБЛЕМИ ЗАХИСТУ ІНФРАСТРУКТУР ПІДТРИМКИ ЖИТТЄЗАБЕЗПЕЧЕННЯ І ЛАНЦЮЖКІВ ПОСТАЧАНЬ

Д. Прохазкова

Існування сучасної людини залежить від надійної роботи інфраструктур підтримки життєзабезпечення і ланцюжків постачань. Для забезпечення безпеки таких критичних інфраструктур і ланцюжків постачань важливо визначити і підтримувати відповідний рівень захисту і контрзаходів проти реальних ризиків. Ґрунтуючись на концепції безпечного суспільства, в людській системі створені сполуки, які об'єднують інфраструктури підтримки життєзабезпечення і ланцюжки поставок. Оцінка шкоди, викликаного збоями, і рівень управління цими збоями виявляє визначено-ні проблеми в досліджуваних сферах, які вони були використані для формулювання вимог до майбутніх досліджень.

Ключові слова: інформаційна безпека, функціональна безпека, інфраструктури підтримки життєзабезпечення, критичні ланцюжка поставок, відмова, вимоги до майбутніх досліджень.

ОТКРЫТЫЕ ПРОБЛЕМЫ ЗАЩИТЫ ИНФРАСТРУКТУР ПОДДЕРЖКИ ЖИЗНЕОБЕСПЕЧЕНИЯ И ЦЕПОЧЕК ПОСТАВОК

Д. Прохазкова

Существование современного человека зависит от надежней работы инфраструктур поддержки жизнеобеспечения и цепочек поставок. Для обеспечения безопасности таких критических инфраструктур и цепочек поставок важно определить и поддерживать подходящий уровень защиты и контрмер против реальных рисков. Основываясь на концепции безопасного общества, в человеческой системе созданы соединения, которые объединяют инфраструктуры поддержки жизнеобеспечения и цепочки поставок. Оценка вреда, вызванного сбоями, и уровень управления этими сбоями выявляет определенные проблемы в исследуемых сферах, которые они были использованы для формулирования требований к будущим исследованиям.

Ключевые слова: информационная безопасность, функциональная безопасность, инфраструктуры поддержки жизнеобеспечения, критические цепочки поставок, отказ, требования к будущим исследованиям.

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