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CRITICAL TRANSPORT INFRASTRUCTURE PROTECTION: A RESEARCH ON THE SECURITY OF THE SUPPLY CHAINS

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***Abstract**: Risks associated with the supply chains belonging to the transport sector of critical infrastructure protection and require appropriate responses and preliminary measures respectively. The analysis of the focuses and objectives of the particular researches points out the needs for complex approaches and the expectations for multipurpose applicability of the results. Starting from the threats, the successful researches identified the need for advanced network analysis to reach door-to-door security along the whole length of the supply chain.*

Keywords: critical infrastructure protection, door-to-door security, network analysis, supply chain security

1. Introduction

The Critical Transport Infrastructure Protection Priority Research Area was carried out as part of the Project #TÁMOP-4.2.b-11/2/KMR-001. The research team enjoyed full autonomy since the inception of the sub-programme in line with the best practices of the leading countries of the topic researchers. In the United States of America, and in the European Communities the critical traffic infrastructure researches, the development of the legislation concerning the security of the vital transport and logistics systems and their implementation forms a substantive sector within the entire critical infrastructure protection researches.

The main objectives at the submission of the application for the research programme were determined as follows:

1. Conceptualisation of critical infrastructure protection and the possible adaptations of foreign experiences respectively.
2. Analysis of the spheres, sectors, institutions and legal frameworks of the critical infrastructure protection according to international examples.
3. The role of traffic systems in the critical infrastructure protection.
4. Allocation of the assignments and methodologies for each traffic modes (air, land, rail, sea, inland waterways, pipeline and cable transports) in critical infrastructure protection.
5. Vulnerability analysis of the infrastructure elements of traffic modes and sectors (e.g. carriageways and tracks, structures, terminals, vehicles, facilities and equipment, control systems etc.) in the European Union as well as in Hungary. Possible risk areas for the analysis may be terrorism, natural and human-made disasters, technological hazards, sabotage, anomalies, incidents, accidents and global warming related environmental effects.
6. Analysis of the interactions between traffic systems from critical infrastructure protection's point of view.

7. The interdependency of the traffic systems on the critical infrastructure protection of the energetic networks, info-communication technologies, food and water supplies, financial systems, public administrations and government sectors.
8. The interdependency of the security and defence sector on the critical traffic infrastructure protection.
9. Security and safety researches at the priority areas of the supply chains and logistics networks.

The priority area of the critical traffic infrastructure protection was not handled independently from other infrastructures due to the interdependency between the traffic networks, means of transportation, individuals, goods, services circulating in the systems and, for instance, the energetics, info-communication systems etc.

The research team were composed of nine academic researchers, four Ph.D. candidates and an M.Sc. student. Introducing the facts and figures concerning the key research indicators, we may mention two strategic and a practical research report, 17 articles published in academic journals as well as 28 conference presentations. The 15 and 8 chapters consisting books were considered as one of the main achievement of the project. Both books were issued in prints and e-book versions. These books indicate the project's priority in talent management, because known researchers of the topics worker with young researchers and doctoral candidates side by side on publishing their results.

After obtaining the support for the researches, its priorities were supplemented with additional areas due to a quick international research trends analysis and risk assessment. These important topics were the supply chain security, the public awareness in emergency situations and their preparedness capabilities. These amendments were proven important from both the public expectations' as well as the research objectives' points of view. The dependency from technologies increase continuously in the postmodern age and the issue of security become more and more priority either from its economic, socio- or other approaches. [1] This study will sum up the research results of the supply chain security area.

2. The Result of a Globalised World: the Globalised Supply Chains

Probably the statement sounds like a commonplace, but we have to accept that we live in the age of a global world in which, no economy can function without the security of supply chains. A permanent barrier in the supply chain, for instance, may paralyse the production, distribution and sales processes a few thousand kilometres away. At the beginning of the research we set up the hypothesis that there is no sufficient what to discuss about the protection of the traffic systems within the greater phenomena called critical infrastructure protection. In our opinion, 'critical infrastructure protection of the transport and logistics sector' would be a more appropriate term.

In the recent decades, the supply chains have become a part of life for the societies and even for their individual members. For those who do not believe this fact we suggest a very simple empirical method to en-sure the statement. We do not need to do anything else just estimate the share how much of our cloths were manufactured in the Far East? The energy sources, clothing, technical equipment, a good portion of food products – consumed by everyday people – were elaborated in countries far away. These products were manufactured, distributed and sold through complicated systems until they get to the consumers. For the everyday people it is almost incomprehensible how the economics and logistics processes and the mechanism of supply chains operate.

The previously unimaginable integration could not have taken place without the spread of a global economic approach, new manufacturing techniques, improvement in

transportation modes and methods of logistics, the increased use of IT systems, etc. New economic trends appeared, certain technologic advances became integral parts of the system while consumer's habits were also changed. These achievements led to the spread of the advanced supply chain management. [2]

2.1. Defining a Concept

However, the definition of the supply chain concept is not easy. Just as for the terms of security, terrorism and logistics, we can find hundreds of conceptual definitions for the supply chain that meet certain scientific standards. The common feature of the supply chain related concepts is that the circulation of materials and products is always associated with the flow of information – this approach appears everywhere. [3] Three main sections may be separated in the supply chain for the material and information flow related processes such as the procurement, the manufacturing and the customer services. [4] It is not necessary to be a logistics expert to imagine when a product that is developed in Europe or in the United States, manufactured in China from elements originating from almost all over the world may become a part of the global sales process if those processes are well coordinated. In such a complex and networked system the cooperation has to cross over the traditional corporate structures. [5] The supply chains are one of the occurrences of globalization. They have been created and, at the same time maintained by the internal values of this phenomenon. To be protected against the harmful effects of the global supply chain may be efficient if its operational mechanism is well considered and their opportunities are exploited. [6]

2.2. Challenges of our Times

The protection of sources of supply, manufacturing plants, warehouses, commercial facilities cannot be considered as a recent issue. Throughout the history after the formation of organized human society the protection of these facilities has always been a priority to the owners and to the states as well. It is no exaggeration to say that both the security of economy and trade became a strategic issue from public administrative and military aspects. In the Cold War period, the opposing parties were evaluated security only in military terms almost exclusively. After the disintegration of the bipolar world, security studies have become more open to other aspects of the real world then the military and foreign policy problems, which were in fact their primary focus in that time. [7] However, it would be a mistake to state that the altering 'new security challenges, risks and threats' (as these phenomenon are often specified by security experts), such as terrorism, the mass migration, drug trafficking and other forms of organised cross-border crime, etc. have not previously been posed threat to the societies and the states. [8] The post-modern society and the evolution of civilization entail numerous challenges that pose serious risks to the global, continental, sub-regional security. The increasing environmental burden shifting, the negative effects of the overpopulation and global warming have already impact on the food production and supply chain. This made the elaboration of strategies and action plans necessary to face such challenges.

2.3. Examinations in the Focus

Our recent time pre-eminent thinkers are preoccupied with the examination of the post-modern societal and technological improvements related phenomena. The French philosopher Jean Baudrillard who died in 2007, published several studies in the preparation to the millennium. These studies dealt with the phenomena emerged in the 1990s and the characteristics of the postmodern era. In his works the resources of security risks were also affected. He investigated the primary problem sources of the inequality in controversial political and economic relationship between the West and the Middle East, Southeast Asia, Africa and Latin America. However he broke with the geopolitical context that was traditionally interpreted as a reference model 'North vs. South'. [9]

The author interprets the term of globalism in the opposition and the mutual interdependency between the West and the less developed parts of the world. Baudrillard's novel approach is thought provoking in many aspects.

3. Geopolitics and General Security Contexts

You should be aware of the geopolitical contexts in relation to the security of supply chain just as of its continuous analysis. Since 1990, we have witnessed a change that amended the economic and security dimensions and most probably have reshaped the geopolitical map of the world. There is no doubt that the 'BRICS countries' have a decisive role in the world economic developments. The Goldman Sachs introduced the term that incorporates countries might join the group of economically developed countries in a longer perspective and includes Brazil, Russia, India, China and South Africa. [10] These countries have already proven their unavoidable role in transportation of certain groups of goods throughout the supply chains.

3.1. Mandatory Network Analysis

At this point we need to turn to the networks. Not surprisingly BRICS countries may be found among the most frequent container ports of the world and they form a vital network of supply chains with the most developed countries added with certain choke points, such as Singapore. The last mentioned type of in-between nodes as the graph theory and as the network analysis calls 'betweenness centrality'. Since they provide not simply links between two important groups of nodes, but these types of connections quantify the number of times a node acts as a bridge along the shortest path.

If we want to ensure 'door-to-door security' in the networks of supply chains, we need to turn to recent achievements of the network analysis. It is absolutely necessary to define those parts of the network, where security measures would affect the most. With other words, we have to point out the most vulnerable points on the shield of defence and target our limited capabilities accordingly to protect the network as effectively as possible. From this aspect, betweenness centrality nodes have just as high relevance, if not even more, than the points of in-degree and out-degree, which are used for the most frequent input and output points of the network.

If supply chains form a scale-free network [11] the network gets a high degree of fault tolerance and may not be disrupted by random attacks with ease, because of the proven character of such network types. In order to disrupt it, targeted attacks have to be triggered at those nodes, which have the highest number of links. This knowledge has been proven to be useful for those who are committed in destroying and in protecting the network.

3.2. Global Network Patterns

The global economic character may not simply be considered, because of the capital investments and settlements of economic operators favour those areas where the necessary conditions are provided for a continuous and prosperous operation. The sources of raw materials, the repository areas, production sites, sales and distribution systems often lie thousands of kilometres away from each other. How to guarantee security along with the transportation routes between these points? Supply chain security is therefore a serious challenge for global, continental, regional, and national level. [8] Although the slogan 'think globally, act locally' originates from the environmental protection, it stands for the security efforts in the supply chains as well, and probably will lead us to better solutions.

A good example is the Icelandic volcano *Eyjafjallajökull* eruption in April 2010 to certify the above statements. In Iceland, such natural effects frequently occur and usually require no fatalities. But the secondary regional and global impact were even worst than the direct primer local consequences in that particular case, because a serious disruption occurred

in the air transport system all over Western Europe. The magnitude of the damage has not been estimated from the missing airfares happened due to the cut in air transport services. It is almost impossible to express for instance, what secondary consequences occurred from the loss of business travels, or from the delays of air consignment services.
We are already aware of the damages what the Japanese *Fukushima* nuclear power plant disaster inflicted on 11 March 2011 due to an earthquake and a subsequent tsunami. It is less well known, that leading Japanese enterprises in the global IT sector were supplied with inadequate amount of electric energy and therefore they could not maintain their continuous production. If the blackout had not been solved in a relatively narrow time frame this would have caused high risk for the global IT industry, because they sustain a serious disruption. If this occurs, it would further deepen the worldwide economic crisis, because of the IT sectors' high significance in the global economy. [8]
Even those terrorist attacks of strategic relevance, rarely occur extensive direct consequences, but their indirect effects can easily affect the security of the supply chains. Due to the closure of seaports and airports, serious disruptions supervened in the American foreign trade after the series of terrorist attacks against the United States on 11 September 2001. [12] Thus, the terror attacks deemed the most serious so far, pointed out at the same time when terrorism and the countermeasures taken against its consequences may distract the supply chain and, in severe cases, the whole economy. Of course, this stands not only for terrorism, but also for all risk factors may cause such incidents that affects a network of properly functioning supply chains. In the consequences of the interdependency with other infrastructures, the serious changes in the operation of such systems, such as the mentioned forms of shocks, will necessarily impact on other infrastructures.

3.3. Wave-like Diffusions

It is still an unsupported assumption that a serious impact such as a shutdown of infrastructures occurred by an unexpected event will produce a subsequent burden transfer to other infrastructures in a wave-like manner. The first event will trigger the strongest effect that is followed by another and another events repeatedly. The repeated occurrences will have declining effects. This would raise more questions in the prevention, minimization and recovery of damages if this theory were how the case develops. Moreover, this also suggests deciding how many repeated occurrences should be taken into consideration by a more precise estimation of damages, as well as at the use of countermeasures, and by the organised recovery. [13]

4. What Security Studies Should Cover?

As we revealed previously, pre-eminent international thinkers of the post-Cold War era had serious debate on what questions should be involved into security studies and the researches in security. In this regard, Copenhagen School researchers led by Barry Buzan, introduced an internationally acceptable recommendation. Accordingly, those threats may include the changed approach of security, which concerns existence-threatening risks and the respective risk management may take extraordinary measures as necessary. [14]
The future is not simply about ranking among the different risk factors, but the real threat assessment. By the measuring of dangers and risks we need to point out that the supply chain forms a fairly multi-player and many factor system, therefore, its vulnerability also depends on many variables. The only security of the supply chain can be understood as an overall one, which takes from the raw material yields to the consumption or recycling. This phenomenon is expressed by the neatly term 'door-to-door security'. However, due to the large spatial differences in the supply chain such as the Far East, the West European

ports and the Central European logistics service centres, the risks may differ enormously. The new American approach to risk management broke the primacy of terrorism among the threats that was interpreted in general at the transport and logistics sectors affecting mainly the public transport systems. Due to the appreciation of the international economic role of the supply chains we need to expect on the risks of the freight transport systems. [15] Although the attacks against logistic sites and transport vehicles were not so frequent in the history of terrorism so far, these threats must seriously be considered. The attention has been drown by the piracy caused damages in the recent years and the efforts needed to be taken to curb attacks on cargo ships.

5. Examples to Follow

There is a repeated dispute between the parties how far the freedom of entrepreneurship would go and where from the strict rules of security should be prevailed. Issues of supply chain security, the complex nature of potential risks and impacts of the possible occurrences of extreme events require close cooperation of the participant organisations. This problem goes far beyond the scope of the critical infrastructure protection in the transport sector. The cooperation should be extended to the industrial security, more precisely to the production sector. It would be necessary to introduce a clear international regulation - preferably with market and financial consequences - that would take safety aspects into account instead of driving down the expenses of production at any cost. The industrial and the agricultural sector are of those where cooperation should be ensured for the safe operation of supply chains. The food-related scandals of the recent years pointed out that the security must be interpreted for the entire food supply chain involving production facilities, processing plants, commercial units and end users. [16] The mutually agreed procedures highly facilitate the development and control of the rules concerning logistics and transportation services between the two sectors. The collaboration with the participants of food supply chain researches allows examples to follow for the entire operational sector of supply chain security. The lessons learnt accordingly would also foster the proper communication of incidents. [16] The experiences of recent years in this area abound in samples that can be and should be taken over, or also those ones that can already be ruled out. In addition to horizontal forms of co-operation between the sectors it is a major issue to organise the co-operation between the affected transport, logistics and trading companies.

Some guarantee provided for that is keeping the Act on the crucial systems, facilities and its identification, designation and protection as well as the subsidiary implementation regulations. The real step forward would be building up such security systems, which cover all activity forms of the firm comprehensively, instead of fence construction, installation of CCTV systems and the use of security wardens that companies usually do. Providing legal guarantees and the risk of market losses together would not even be sufficient motivations. We need to foster that security should become the part of the organisational culture.

In such a complex system like the supply chain, it is not appropriate to assess risk factors separately. We follow those experts who claim that the security of supply chains should be evaluated with external and internal interactions of risk factors on a complex manner. [17] The ignorance of the interdependencies of security factors occur error in the threat assessment. [18] The exaggeration of certain threat factors would also lead to serious consequences just as ignoring them. [19] The enlarged threat of terrorist attacks increased the complexity of prevention of incidents. [20] The risk of terror attacks against the supply chains may not be underestimated in peace support missions either. As we could see concerning the attacks against ISAF fuel supplies the threat has still a high probability.

6. Summary

The security of supply chains has a strong relation with the critical infrastructure protection, because they are parts of several infrastructure sectors such as energetics, food supply and traffic. The prevention and if the incidents have already occurred, the restoration plays vital role in both areas, where preparedness is always a key. Although we have seen that unpreparedness was attempted to cover by targeted PR several times, filling the gaps like that never succeeded. [21] Preparedness as a mean of security may be effective if each participant follows the rules and meets the standards. Additionally, economic operators, facility owners, governments, their respective agencies and international organisations may be found at this theatre where the entities should co-operate, if they want to achieve their objectives. Bearing in mind that supply chains often connect continents this would not be simple. [22]

We consider high responsibility of the researchers in the supply chain security, because these researches are still on going in many countries involving the EU members and the regulations and means are also developing. In the above-referred project, three researchers dealt with the aspects of supply chain security. Their primary objective was to raise awareness for the Hungarian participants of the area of responsibility and point out that the local approach will no longer provide guarantees in the risk management.

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