

NATIONAL UNIVERSITY OF PUBLIC SERVICE

DÁVID KISS

**The mathematical modeling of the structure of defense economy
system during state of emergency period**

author's description of a doctorate thesis (PhD)

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BUDAPEST

2018

Definition of the scientific problem

As in the legislation of other nations (USA) and the Commonwealth (European Union), the economic sector also appears in Hungary as a critical infrastructure. Nevertheless, neither the Hungarian National Military Strategy nor The Fundamental Law of Hungary provides a satisfactory answer to the role of the economy in an emergency situation and which steps are needed to maintain its operation. Although the National Security Strategy addresses the issues of the economy in several places, we can not regard it as a complex defense strategy yet. The purpose of the Government decree 131/2003. (VIII. 22.) „*About defense preparation and mobilization tasks and implementation of the national economy*” is to clarify this issue, but its content does not reflect the challenges of the XXI. century, the emergencies of security policy conditions, ignores several important economic aspects of protection and therefore can not be considered as guiding document as well.

The hungarian economic and market structure has undergone significant changes after the regime change. The centralized planned economy system was replaced by free market structure, which meant significant changes not only for retail consumers and users, but for corporate and public sector actors as well. The opportunities given by the free market, globalization has become a major source of foreign markets in all sectors, and imports of foreign products have become more and more important, complementing or hindering domestic production. In the 1990's with the elimination of the socialist co-operatives and the large wave of privatization, the domestic production became increasingly underdeveloped against foreign cheap imports. Although the 2010-2014 resettlement program aimed to reduce the level of privatization, it has not been able to deliver outstanding results. The increase of technology's and product dependence's degree significantly influences the economy's normal functioning and thus the special circumstances of the state of emergency period.

During the Cold War the stock- and product allocation and warehousing were dominant for state management. This issue has played a prominent role in the defense measures of both the socialist and the capitalist side, because it was conceived that in case of possible World War III with nuclear weapons the winner would be the one who has larger and better distributed kits. The memories of wars and the limitations of the immediate availability of products, besides the state, have led the people of the Cold War to medium and long-term product accumulation. In households at that time was common to have enough sufficient stock of food, toiletries and other essential necessities for months, while most of today's modern households can not be said that.

Today's economic environment provides consumers with the opportunity to buy and use all products and services straightway and no limited volume, as much as they need at the time they

need. Thus, in the free market system, the consumer society is not characterized by warehousing and product accumulation behavior at all.

Hungary's entry to the free market and the transformation of the economy made it possible to create a dynamically changing economy along the lines of consumer demand. This occurred a complex, state-independent economic structure, which is becoming more and more challenging for the preparation in peace period and the definition of a proper defense strategy in case of emergency.

A dynamically changing economy requires a defense strategy which is developed in a dynamic, reflective way to different special situations, because standard, static planning is not effective enough to address this issue.

With the advances in technology and, above all, the development of computers, has become possible to solve complex mathematical problems that were not possible before. Computers now can do millions of calculations per minute, so they have become more suited to describe the surrounding environment, i.e. creating models than any other method or tool.

In my dissertation I am looking for a solution for the complex economy of the defense industry with a modeling method, which changes dynamically in response to all the elements in the equation. The network analysis can provide a basis for drawing up defense strategies, regardless of the source or scope of the threat, and also takes into account the sensitivity aspects that public executives establish and can process the available and incoming information.

Research objectives

During my research I have set the following objectives:

1. The economic environment of the peacetime (as a consumer trend, economic structure, foreign trade balance, etc.) has changed significantly in Hungary over the past decades. In my research, I aim **to explore** the elements in this renewed environment that may have an impact on the peacetime defense economics preparation as well as the stability of the economic structure in case of the state of emergency period;
2. Emergency cases formulated in the state of emergency have responded to events that are significantly different from each other. My goal is **to identify** the same elements from different cases and thus to form the basis for an abstraction model;
3. Emergency cases formulated in the state of emergency have responded to events that are significantly different from each other. My aim is **to prove** that the network analysis

method is suitable for describing the special circumstances of a state of emergency and for creating a dynamic, adaptive model;

4. Next, I intend **to create** a model based on the network analysis method, which is able to describe critical processes based on concrete, equal and open data, that may occur during state of emergency period, thus helping to build a defense strategy.
5. My aim is **to model and analyze** the special events (external armed attack, natural disaster, terrorist attack) that are marked in laws of state of emergency.

Research hypotheses

During my research I set up the following hypotheses:

1. To describe the economic environment and the dynamically changing market due to the complexity of the economic structure, taking into account the aspects of the protection economy, dynamic models are needed, because static models are not able to respond in an adaptive way to emergencies occurring and can not provide a suitable scenario for defense measures.
2. Regardless of the type of the threat, its scope and subject matter, there are similarities between periods of state of emergency, thus producing an abstraction model.
3. The method of network analysis is suitable for creating a dynamic, adaptive and abstract model, which is able to describe the emergencies in the state of emergency period.
4. Based on open source data can be generated a network that can be used for modelling cases of state of emergency and as a result the damage caused by various economic or other aspects of the various emergency situations.
5. A graph-based model can be further expanded depending on the available data and thus can be specifically set to create a strategy for the given particular emergency.

Research methods

The methodological basis of my research is the network analysis and its characteristics' abstraction. In my dissertation, based on open source data, I create the network of settlement structures of two main counties (Csongrád and Szabolcs-Szatmár-Bereg County), which I use for modelling emergency situations during the state of emergency period. The databases of Hungarian Central Statistical Office and Google Maps can be used to draw up the infrastructural linkage system of settlements, which has a significant influence during a state of emergency period. Network analysis provides options and answers to plan the necessary steps in describing various structure-weakening attacks.

In the course of the study I will perform correlation analysis between the characteristics of the established network and the structural features of the settlements of the counties, then I wish to demonstrate the possibility of using the abstraction model with mathematical methods.

During the dissertation, emergency situations were caused by a virus infection attack, and identifying the critical points of the network and their impact on the network and explain their defense aspects.

Simplified description of results by chapters

In **Chapter I**, I have reviewed the legal framework of state of emergency in the legislation of Hungary and some other nations (mainly European Union member states). Based on these, I have determined that, regardless of the social, cultural, economic and other specificities of the nation, the threats are defined in the same way, and the most of the nations are using a different legal framework than in peacetime to address this. Concentrated power exercises are exerted by the exemplary nations in the cases where life and property security of the population of the country, the continuity of the country's operation or its sovereignty in some way is endangered by human or environmental elements within or outside the border. I have defined the parallel in the legal framework that treats external armed threats, environmental catastrophies, and one of the most pressing problems of our times: terrorism. The reasons for the emergence of the threat are far different from each other, but I have stated in the chapter that, if we take the goals of ordering the state of emergency and the necessary functioning economic system, then we can formulate the key tools in general terms for the management of emergencies is the preventive preparation of the economy in peacetime and the maintenance of its functioning during the state of emergency period.

In this chapter I examined the past and present economic structures of Hungary, how their operation influences the development of the defense strategy and the preparations for the peacetime. I have analyzed the economic tendencies of the current free market structure on several priority points, which proved that in a dynamically changing and shaping economy the static and planned strategies are not intended for the purpose in preparation for a state of emergency.

Along with examining legal frameworks, economic structure, internal and external economic impacts, I drafted proposals depend on the current but obsolete Government Decree 131/2003. (VIII. 22.) „*About defense preparation and mobilization tasks and implementation of the national economy*” about the factors that can improve the effectiveness of defense economics and the pursuit of the stability of the economy during a state of emergency period.

In **Chapter II**. I presented a mathematical method that reflects the specific circumstances of the state of emergency, the dynamic free market structure and the special situations as described in Chapter I and can adapt the information that is relevant in these cases.

With the historical development of graph theory and network analysis, and the presentation of the discussed identities I have proved that the method is able to establish general identities in relation of the structure of the network, regardless of the information content of the network elements, so it can be applied in the present defense economic aspect.

The network structure can also be identified at several places in the defense economics structure, but its modelability has serious limitations that depends on available data. All alternatives based on classified or unavailable data are rejected. An alternative abstraction model has been selected which inverses the subject of the supply of defense economics and indirectly refers to the measures needed to create a defense strategy. Based on the population of the settlements and the transport infrastructure, a network model can be built that does not describe the specific defense economy processes but can be interpreted as a consequences of it.

In **Chapter III**. through the examples of two main counties, Csongrád and Szabolcs-Szatmár-Bereg, I proved that by using the method of network analysis, based on the available open information, the critical points and critical settlements in a settlement structure of a county can be identified, which deserve special attention in handling emergency situations and in developing a defense economic strategy.

The counties were selected based on the fact that more special cases can be modeled by them. In the case of priority counties were the subject of the investigation – depend on environmental and other disasters, cross-border attacks, and cyber attacks, isolated territories, terrorist attacks, possibly internal armed conflicts. I have found that the network structure based on the population, territory and geographical location is not appropriate for describing the propagation mechanism of natural disasters, but it can serve as a basis for the strategy for managing and preventing it.

During the attack simulations of the two examined counties I have proved that the network analysis can properly describe the attacks against isolated points, determine the critical points of the settlement structure, and properly handle the issue of the affected population.

Summarized conclusions

With the research objectives and hypotheses defined in the introduction, I summarize the following conclusions as a result of the research.

In the first chapter, along with the examination of domestic and foreign examples, **I found** that the concept of concentrated power exercises in a state of emergency period is the same unlike

their nation and their unique specifications. In the laws of the nations concerning the state of emergency have similarly defined the sources and types of emergencies, which were mainly distinguished as follows: external and internal armed threats, environmental disasters and terrorism.

The reasons for the emergence of danger are do differing from each other, but in the chapter **I stated**, that if we set out for the purpose of ordering the state of emergency and we take the necessary functioning economic system to do so, then we can formulate it in a general way, that a key tool for dealing with emergencies is the preventive preparation of the economy in peacetime and to maintain its operation during the state of emergency period.

Through the comparison of the pre-regime planning economic structure and the free-market structure, **I identified** the macro-level and general structural features that are important in the defense aspect, which affect the economic system operating both in peacetime and during the state of emergency period as well. With the decline of state role in economy and with the opening up of the markets and the complexity of the economy makes it much more difficult to prepare and manage the economy in state of emergency period and preparing for it in case of the free market structure.

In the current free market structure the dramatic increase of state involvement in economy is not a realistic idea. **I have found** that the current legislation does not reflect correctly on the XXI. century's economic and security policy challenges and can therefore be regarded as obsolete from the aspect of defense economics. **I have put forward proposals** on the current legal framework and its content review, where I have found that, in the present security policy environment, when preparing for the state of emergency period, we can not be considered as the primary objective of reserving and stockpiling - as well as the fact that the current data reporting system does not provide sufficient and frequent information on the current status of the economy to establish an appropriate structure for the protection economy.

Based on these, **I have found** that the most effective tool for preparing defense economics and creating a defense strategy for state of emergency period is the use of a model based on mathematical methodology which can build in other static data (and incorporate new information), that can process together with the complexity of the economy, and able to adapt to the specific events of specific cases occurring during the state of emergency period.

During the research, **I have proved** that graph theory based network analysis has the necessary criteria to create the desired adaptive model. The methodology, regardless of the information content of the points in the network, is able to examine general structural features and able to determine the critical points of the system.

During examining available information, **I found** that the structure of the defense economy can not be made up of open source data, but an abstract model based on the settlement structure of the counties, the population of settlements and the road network system can be the basis for the defense strategy.

Launching from the subject of the protection and defense measures, I placed the focus of the investigation on the people, whose security wants the state to ensure during state of emergency period, and thus indirectly abstract conclusions can be drawn to the defense economy, its continuity and stability.

Nevertheless, **I stated** that the structure of the defense economy can be built with the necessary (secret) information, and the open source data based model can be further expanded along the defined preferences during the strategy creation, such as the applicability of the network analysis methodology has proven.

Through the presented attack simulations during the research, **I have proved** by way of example from Csongrád and Szabolcs-Szatmár-Bereg County, that in case of different emergency situations the open source data based model can and should be used, with the exception of natural disasters that are independent from road infrastructure, where the model can be likewise used as the organization and planning of care.

New scientific achievements

- I. **I defined** the similarities between the periods of the state of emergency based on The Fundamental Law of Hungary point of view of the defense-economic, and then **determined** the important macro-level, general structural economic criteria those influence both the pre-emptive economic preparation in peacetime and the creation of the necessary strategy for state of emergency period, and on this basis **I made a proposal** for the steps needed to develop Hungary's more effective defense strategy.
- II. **I have proved** that the graph theory based network analysis is a mathematical methodology that can model defense economy structure due to its dynamic and adaptive nature as required by the current economic structure and environment.
- III. **I have proved** that the model of a settlement structure based on open source data underlined by residential, territorial and road networks can be used to model a number of specific legal time periods, so it can be used to develop a defense strategy.

Recommendations

The focus of my dissertation is on the applicability of a model, which can provide a methodological basis for the defense strategy and which is able to react appropriately the various unexpected emergencies that the static models and designs do not provide a satisfactory answer.

The security and continuity of the economy in this aspect is indispensable for the preparation of the dynamically changing economy in peacetime and for dealing with emergencies. On this basis I recommend my dissertation primarily for **Ministry of Defense, Department of Defense Administration**, which is mainly related to the elaboration of the defense strategy, the preparation of the strategy, its implementation and coordination. In addition I recommend my dissertation to the disaster management institutions and those (economic) actors, who are actively involved in the economic defence strategy during state of emergency period or in the preparation for the preceding peacetime. By recognition of the dissertation, these actors can incorporate their professional experience into the process of creating a model and strategy. As a result of this, the further development of the model ensures that the economic processes can be described more precisely and thus it becomes more effective in dealing with various emergency situations. And finally, I recommend my dissertation to those institutions that can be connected to the road and railway network from an economic point of view either from the public or from the private sector, because the model can be transformed efficiently in the development of these systems or in optimizing their utilization.

Practice of research results

The methodology presented in the research can be effectively used to solve and optimize the logistical problems and supply tasks necessary in order to deal with emergencies in state of emergency period and to develop a defense strategy. Network analysis, based on observations of the thesis, provides an exact mathematical basis for planning the continuity and stability of the defense economy and thus provides an effective tool for optimizing the economic processes. It can adequately determine the critical points of the settlement structure system in case of isolated attacks, border attacks and concentrated targeting attacks during the state of emergency period and thus providing a basis for defense preparation from an economic point of view as well. The method and the model can also play a key role in the management of the state of emergency and in the implementation of the defense strategy, because it adapts all the special circumstances and special events that are significantly different from the peacetime operation and problems. It can be further developed based on the needs of state leaders and the experience of the executives of the defense strategy, and can be extended with additional criteria that increase the efficiency of the model and provide more accurate responses to emerging emergencies and their handling.

List of publications of the author related to the topic

I. LECTURED BOOK, BOOK CHAPTER, NOTE

1. Kiss Dávid: Az ellátási lánc szállítási szegmensének vizsgálata mikro és makroszinten illetve annak kritikusságának elemzése a hálózatelemzés módszerével különleges jogrend idején. In: Horváth Attila, Bányász Péter, Orbók Ákos (szerk.): Fejezetek a létfontosságú közlekedési rendszerelemek védelmének aktuális kérdéseiről. Budapest, Nemzeti Közszolgálati Egyetem, 2014. pp. 101-120.

II. LECTORED PUBLICATIONS IN SCIENTIFIC JOURNALS

1. Kiss Dávid, Váczi Dániel:

A vállalatok és a kritikus infrastruktúrák humánhálózata ellen irányuló támadások veszélyei a komplex hálózatok elemélete alapján. In: Hadtudomány: A Magyar Hadtudományi Társaság Folyóirata (ISSN: 1215-4121) (eISSN: 1588-0605) 28: (1) pp. 151-168. (2018)

2. Kiss Dávid: Hálótervezés és hálózatelemzés a védelemgazdaságban – 2. rész. In: Hadtudomány: A Magyar Hadtudományi Társaság Folyóirata (ISSN: 1215-4121) (eISSN: 1588-0605) 28: (1) pp. 101-112. (2018)

3. Kiss Dávid: Hálótervezés és hálózatelemzés a védelemgazdaságban – 1. rész. In: Hadtudomány: A Magyar Hadtudományi Társaság Folyóirata (ISSN: 1215-4121) (eISSN: 1588-0605) 27: (3-4) pp. 43-53. (2017)

4. Király László, Kiss Dávid:

A védelemgazdaság helye a tudományok rendszerében és fejlődése az elmúlt évtizedek során. In: Társadalom és Honvédelem XX. évfolyam 2016. évi 2. szám, pp. 91-100

5. Király László, Kiss Dávid:

A pénz, mint fegyver. In: Társadalom és Honvédelem XIX. évfolyam 2015. évi 2. szám, pp. 199-210

6. Kiss Dávid: A gazdasági szervek működési, termelési monitoringjának elméleti kérdése a különleges jogrend időszakára való felkészülésben. In: Hadmérnök (ISSN: 1788-1919) 10: (4) pp. 115-126. (2015)
7. Kiss Dávid: Structural similarities and differences between the hungarian economic system of state of emergency period and the 20th-century planned economy. In: Economics and Management (ISSN: 1802-3975) 2: pp. 55-62. (2015)
8. Kiss Dávid: A közlekedési kritikus infrastruktúra sebezhetőségének elméleti vizsgálata a hálózatelemzés módszerével. In: Társadalom és Honvédelem XVII. évfolyam, 2013. évi 3-4. szám, pp. 182-194

III. INTERNATIONAL PROFESSIONAL'S CONFERENCE PRESENTATIONS PUBLICIZED

1. Horváth Attila, Kiss Dávid, Orbók Ákos:

The theoretical possibilities of the optimization of defence against terror attacks using social network analysis. In: Management - Theory, Education and Practise 2014: Conference proceedings of the International Scientific Conference, Slovakia, ISBN:978-80-8040-496-3 pp. 246-252 (2014)

IV. HUNGARIAN PROFESSIONAL'S CONFERENCE PRESENTATIONS PUBLICIZED

1. Kiss Dávid: A védelemgazdaság mechanizmusában szereplő vállalatok hálózatának strukturális alapjai. In: Hadszintér előkészítés, létfontosságú rendszerelemek védelme, honvédelmi érdekek érvényesítése, Poszter kiadvány, Magyar Hadtudományi Társaság, Budapest, 2015., ISBN 978-963-12-1507-6, pp. 29-30. <http://mhtt.eu/files/2015/POSZTERKIADVANY.pdf>
2. Kiss Dávid: A nemzetközi piac szerepe a piacgazdasági struktúrában és annak vetülete a különleges jogrend gazdasági szerkezetére. A Tudomány Kapujában poszter kiadvány, Magyar Hadtudományi Társaság, Budapest, 2016., ISBN 978-963-12-4965-1, pp 51-52.: <http://mhtt.eu/files/2016/Poszter16.pdf>

Author's professional and scientific curriculum vitae

Name: Dávid Kiss

Place and date of birth: Budapest, May 4, 1987

Professional and scientific lifeway

I finished my high school studies at the Vörösmarty Mihály Secondary Grammar School, and after graduation, I have been admitted to the Faculty of Economics at the University of Kaposvár, with economist-management profession. During the University scientific life and scientific work has attracted my interest. My first Student Science Circuit was awarded the first place, so I was able to present my research findings at the national round in the following year. During my studies I got another position on the university round and I was able to test myself again at the national round. During my university years I participated in the scientific and educational work of the Department of Mathematics and Physics, as a demonstrator between 2007 and 2010.

My doctoral training started in 2013 at the Doctoral School of Military Engineering of the National University of Public Service, and in 2016 I got my absolutorium. I participated as a PhD student in the Department of Operational Logistics at the Military Logistics Institute and as lecturer at the Department of Military Supplies and Military Transportation. As a researcher I could join the work of the Project of Critical Transport Infrastructure Protection Priority Research Area, #TÁMOP-4.2.b-11/2/KMR-001, during which I examined the network structure of the supply chain.

I'm an active member of The Association of Hungarian PhD and DLA Students Section of Military Sciences, and The Hungarian Association of Military, The Defense Economics and Logistics Section and Science Kápolnai Pauer István Youth Club. During the last few years, I received the recognition of the article of the Hungarian Military Society twice.

Currently, I am an economic rapporteur at the scientific vice-rector of the National University of Public Service, as well as the responsible economic coordinator of the New National Excellence Program.

Language skills

English – intermediate „Type C” language exam with a professional (economic management) vocabulary

German – intermediate „Type C” language exam with a professional (economic management) vocabulary

Budapest, October 15, 2018

Dávid Kiss