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T. Ekström, PhD, assistant professor¹

(0000-0002-7838-7044)

T. Listou, PhD, associate professor²

(0000-0002-8648-0302)

Y. Hannenko, PhD, associate professor³

(0000-0002-5684-5593)

¹ – Swedish Defence University, Stockholm, Sweden;

² – Norwegian Defence University College, Oslo, Norway;

² – National Defence University of Ukraine, Kyiv, Ukraine

Societal resilience in theory and practise

Abstract. The article outlines the first steps towards creating the foundations for further research into the logistical aspects of warfare in the context of societal resilience. The possibility of achieving seven basic indicators of national stability, the organization and network of using the strategy of rapid response to threats to achieve efficiency, reliability and stability of the state are considered.

Keywords: infrastructure; logistics; NATO; russian-ukrainian war; supply chain.

Formulation of the problem. Building resilience is a critical endeavour in today's world, where emerging threats and modern warfare demand innovative approaches. On the 24th of February 2022, Russia initiated a full-scale invasion of Ukraine, thus escalating the ongoing Russo-Ukrainian war that began in 2014. Russia simultaneously attacked Ukraine from the north, east and south. It is likely that Russia expected its invasion to be a blitzkrieg operation [1]. However, after meeting intense defence from Ukraine, the Russians regrouped and reinforced the operation to the East and the South. The war has now developed into a war of attrition, or a war between supply chains, impacted by economic sanctions on Russia and military support to Ukraine. It is also clear that the war extends beyond military units and their supply chains. The Russians also target critical infrastructure, as well as civilian facilities.

Since the formation of NATO, other nations have not attacked its territory militarily as an act of war, whereas Ukraine now experiences the first full war on European soil since NATO formulated the articles of its Treaty. The war is primarily a tragedy for humanity in general and the Ukrainian people in particular. However, there are lessons that NATO can learn by studying the continuous Ukrainian resistance as an outcome of its societal resilience and how it can withstand armed attacks on its infrastructures and supply chains.

The Russian war in Ukraine illustrates four generic operational requirements on any military force, including the Armed Forces of Ukraine (AFU): availability, preparedness, mobility, and sustainability. The purpose of this paper is to take the first steps towards developing a framework

for further research into these logistical aspects of warfare, in the context of societal resilience.

Analysis of recent research and publications. The analysis of the latest scientific research and publications [1, 3, 4, 48] shows that a number of works of predecessors, who in their time made a significant contribution to the development of the theory of military science, are devoted to the analysis of the stability of logistics in the russian-ukrainian war. But few studies have been conducted on the analysis of the logistical aspects of the russian-ukrainian war in the context of the stability of society and the Armed Forces of Ukraine, especially at the beginning of the large-scale armed aggression of Russia and the territory of independent Ukraine.

The NATO treaty and its requirements on resilience. A country's ability to cope with major crises such as wars rests on its capacity to connect organised actors, as well as voluntary actors and non-governmental organisations, in a 'whole-of-nation' approach, to interact and utilise all resources available to the society. Such systems make up the resilience of the country and comprise centrally coordinated governmental actors, commercial actors, volunteers, and individuals, all driven by their values and norms, and restricted by the resources at their disposal.

Article 3 in the NATO Treaty states that "In order more effectively to achieve the objectives of this Treaty, the Parties, separately and jointly, by means of continuous and effective self-help and mutual aid, will maintain and develop their individual and collective capacity to resist armed attack" [2]. Article 3 does not explicitly mention resilience, but NATO has made it clear that the meaning is that "Each NATO member country needs to be resilient to resist and recover from a major shock such as a

natural disaster, failure of critical infrastructure, or a hybrid or armed attack. Resilience is a society's ability to resist and recover from such shocks and combines both civil preparedness and military capacity" [3]. At the Warsaw Summit (2016), NATO specified its seven baselines for national resilience [4]:

- assured continuity of government and critical government services;
- resilient energy supplies;
- ability to deal effectively with uncontrolled movement of people;
- resilient food and water resources;
- ability to deal with mass casualties;
- resilient civil communications systems;
- resilient civil transportation systems.

At the Brussels Summit (2021), NATO "pledged to expand innovation, resilience, adaptability, and a technological edge", and established five interdependent Warfare Development Imperatives, including "layered resilience", "Fundamental to a strong defensive alliance is the ability to withstand a shock and fight-on. NATO's Allies must ensure that weak points, both military and civilian are reinforced, and are sustainable in challenging situations over extended periods of time. This includes essential tools like supply lines and communications, but also that societies are resilient against disinformation" [5].

In summary, Article 3 in the NATO Treaty requires that member states design their civil preparedness and military capacity so that their societies are resilient against major shocks. This overarching requirement encompasses requirements on resilient supply chains, resilient infrastructure systems and resilience against disinformation. It also includes requirements on transportation systems and healthcare systems that can deal with sudden mass movement of people, as well as mass casualties.

Operational on military logistics. All military logistics systems have to satisfy certain operational requirements to support the armed forces. However, there are no universal, uncontested terminology and definitions in this area. In this paper, we differentiate between requirements on availability, preparedness, mobility and sustainability. No military logistics systems can satisfy all operational requirements by itself. The logistics system will depend on functioning infrastructure systems to deliver mobility, as well as functioning commercial supply chains to deliver sustainability.

Availability and preparedness are different aspects of the overarching term readiness. There is a distinction between "ready for when",

operational readiness, and "ready for what", mobilisation readiness [6] (p. 216). Operational readiness is equivalent to availability, whereas mobilisation readiness equals preparedness. Availability is the ability of a military unit to participate in operations immediately, after activation. Preparedness, on the other hand, is the ability of a military unit to participate in operations within a specified timeframe, after mobilisation.

The operational requirements on availability and preparedness both entail that a military unit must have access to, in their permanent bases, supplies for the initial phase of an operation, which means that a specified number of days of supply must be stored at the bases [7] (p. 32). In peace, military logistics organisations and industry deliver supplies to permanent bases to ensure availability and preparedness. However, to deliver operational capability, the military units will also require access to its personnel. In many cases, this means that several infrastructure systems, such as transportation, communications and electricity, must function to enable personnel to reach the permanent bases.

After activation or mobilisation, military units will probably have to move to temporary bases or an area of operations. This will require mobility activities, such as deployment, sustainment and redeployment. Even if the military units have enough transportation resources, they will be dependent on several infrastructure systems, such as the road and railway networks, which must be operational to allow the military units' mobility. They will also require functioning systems for fuel distribution, telecommunications and electricity.

After depletion of the initial allowance, soldiers and units will become dependent on a more or less continuous flow of resupplies from storage facilities, or directly from suppliers, to ensure sustainability for the duration of an operation. Military logistics units will deliver these supplies to military units in temporary bases or in areas of operations. Sustainability is the ability of a defence force to maintain the necessary level of combat power for the duration required to achieve its objectives. Like mobility, this requires functioning infrastructure systems, such as the road and railway networks, telecommunications and electricity. However, sustainability also requires functioning commercial supply chains. Production, storage and distribution must function at private sector companies to ensure sustainability.

Supply chain responsiveness, robustness and resilience. Over the past decades, supply chains and supply chain management have become more complex. Because of cost-efficiency initiatives, outsourcing, and global sourcing, supply chains have also become more vulnerable to demand variability and disruptions [8, 9]. Vulnerability to demand variability has motivated researchers to explore supply chain responsiveness [10], whereas vulnerability to disruptions such as war, terrorism and natural disasters, has inspired research in supply chain resilience [8].

Supply chain responsiveness. Regarding vulnerability to demand variability, supply chain responsiveness is the opposite of supply chain efficiency [11, 12]. Efficiency (cost-orientation) and responsiveness (customer-orientation) are the two fundamental dimensions of competitive priorities [13]. Efficiency is a supply chain's ability to compete on costs, whereas responsiveness is a supply chain's ability to compete by responding quickly to market movement [14]. Efficient (lean) supply chains have long production lead-times, high set-up costs, and large batch sizes, while responsive (agile) supply chains have short production lead-times, low set-up costs, and small batch sizes [15].

Supply chains must be context-specific and optimised for a particular competitive environment [16]. Companies should consequently customise their supply chains to match the customers' requirements [17]. However, for defence supply chains, there is an added complexity, since they must be lean and efficient in peace, but agile and responsive in war [7, 18]. In addition, defence supply chains must also have the ability to switch from peace to war quickly [19]. Furthermore, defence supply chains support armed forces to achieve operational outcomes, not financial outcomes [20], which presents companies with unique supply chain design issues to consider [21].

Supply chain robustness and resilience. Regarding vulnerability to disruptions, supply chain resilience is the opposite of supply chain efficiency [22]. Supply chain resilience is the ability of a supply chain to return to its original state, or move to a new, more desirable state after being disturbed [22], and events such as terrorist attacks, tsunamis and hurricanes have motivated researchers to consider disruptions and their effects on supply chain design [23]. Some researchers consider such disruptions as one of the most crucial planning problems in supply chain management [24].

The objective of supply chain resilience is to reinforce the ability of the supply chain to resist disruptions and recover quickly with minimal cost and effort [25]. A recent definition of supply chain resilience states, "A resilient supply chain should be able to prepare, respond and recover from disturbances and afterwards maintain a positive steady state operation in an acceptable cost and time" [26]. The definition illustrates the emerging view that there is a pre-disruption phase, a during-disruption phase and a post-disruption phase, which all require different types of strategies to enhance supply chain resilience. Researchers have proposed various strategies to manage disruptions [24]. However, several researchers acknowledge the effectiveness of a limited set of strategies, including flexibility, agility, collaboration, and redundancy [22, 27, 28].

Analogous with the three phases of disruptions, resilience strategies are categorised as proactive, concurrent and reactive strategies [29], or only proactive and reactive [30]. The two most frequently discussed types of strategies are mitigation strategies (proactive strategies) and contingency strategies (reactive strategies) [24]. For mitigation strategies, decision makers take preventive actions and pay their costs in advance, while for contingency strategies, decision makers take action only when a disruption occurs [27]. The most frequently used strategies to handle disruptions are increased safety-stock, dual or multi-sourcing, and better forecasting [31].

The first academic articles on supply chain resilience appeared in the literature twenty years ago. After two decades, there is still no consensus regarding definitions, terminology, concepts or constructs [23, 29]. As an example, how resilience relate to robustness is still in contention [32]. In this paper, we make a distinction, and consider robustness and resilience to be different properties of a system, related to the different objectives of stability and adaptability, respectively. An ongoing debate of particular interest to this paper is therefore the one regarding the origin of the concept of resilience. The strongest contenders are engineering and ecology on the one hand [33, 34], and psychology on the other [35]. Whoever came first may be of academic interest only, but depending on origin, or area of development, these three topical areas provide quite different views and perspectives on supply chain resilience, which can all be useful in research on societal resilience.

In engineering resilience, the unit of analysis is frequently an organisation or (a part of) the supply chain [36], which is regarded as a

closed system [33]. Engineering resilience is frequently associated with robustness, the ability to resist a disturbance by not changing [32]. Engineering resilience strives for a fail-safe design and focuses on the speed of return to an equilibrium steady state (time-to-recovery) and resistance to disturbance (time-to-survive) [33]. Engineering resilience is the ability of a system to recover and return to a stable state, which is in line with a stability-based view on resilience [34]. The stability-based view on resilience in engineering deals with designing a robust system, without studying exogenous factors, which can return to its initial state after a disruption.

In contrast to engineering resilience, ecological resilience allows a safe-fail design and focuses on the level of disturbance that a supply chain can absorb before it changes its structure [33]. Ecology consequently sees resilience as changing and adapting in response to a disturbance [32]. In the context of supply chain management, this means that managers should strive for adaptability and transformability [33]. Ecological resilience is the ability to survive and exist, through adaptation, which is in line with the adaptation-based view on resilience [34]. The adaptation-based view on resilience in ecology deals with designing a resilient system, which can adapt and transform because of a disruption.

The advocates of an origin in psychology declare that resilience has its roots in individual psychology and the science of child behaviour [35]. In psychology, researchers study resilience as the ability of individuals and families to withstand, bounce back and recover from traumatic events [37]. As opposed to resilience research in engineering and ecology, where researchers study resilience at the system level, researchers in social system resilience study the individual parts of the system [38]. Building on ideas from the psychology resilience perspective, researchers have proposed four levels of analysis to study resilience in social systems, individuals and teams, organisational, supply chain and network, and sectors, national and supranational [39].

Infrastructure in robustness. The NATO baseline requirements describe resilience related to both the infrastructure systems of the member nations and their resources and supply chains.

As claimed by [40], infrastructure is “the framework of interdependent networks and systems comprising identifiable industries, institutions, and distribution capabilities that provide a reliable flow of products and services essential to the defense and economic security [of the United States], the smooth functioning of

government at all levels, and society as a whole”. They list telecommunications; electrical power systems; gas and oil storage and transportation; banking and finance; transportation; water supply systems; emergency services; and continuity of government as the most critical of these investments.

Whereas e.g., Pires Ribeiro and Barbosa-Povoa [26] describe resilient supply chains as those that can prepare, respond, and recover from disturbances, an infrastructure cannot do so. It can however be prepared and be recovered from disturbances. Rather, the supply chains supporting the infrastructure need to have these properties. Hence, we contend that from a societal resilience perspective, infrastructures need to display properties of robustness combined with properties of resilience of their supporting supply chains. In our work we build on Torrisi [41] and Buhr [42] and their categorisation of infrastructures as material, social, and institutional infrastructures.

Researchers in the areas of logistics and supply chain management, implicitly assume that infrastructure is restricted to production and warehousing nodes, connected by transport links. As such, the concept of infrastructure is treated as an important asset, although not always explicitly defined [43] and not necessarily including external infrastructure systems, such as telecommunications and energy supply. Relating this to the discourse between an engineering / ecological view on resilience versus a psychological one, an engineering approach to infrastructure robustness would focus on the material attributes of infrastructure and measures to protect it against kinetic or digital disruptions. The NATO baseline requirements for energy supply, transportation, and communications systems outline conditions for such material infrastructures. Material infrastructure is defined as “those immobile, non-circulating capital goods that essentially contribute to the production of infrastructure goods and services needed to satisfy basic physical and social requirements of economic agents and unavailable to the individual economic agents (households, firms etc.) for production and cost reasons so that mass production is economically cogent” [42]. For example, the need of drinking water is met by the corresponding supply of water collected in a reservoir [41] (p. 12). Torrisi further exemplify material infrastructure as roads, highways, airports, naval transport, sewer networks, aqueducts, networks for water distribution, gas networks, electricity networks, irrigation plant

and structures dedicated to the commodities transfer.

The material infrastructures' ability to resist an armed attack hence depends on both the proactive and reactive strategies undertaken by the infrastructure owner, exemplified by the Ukraine efforts to protect and maintain their energy infrastructures. Before 2022, the Ukrainian power grid was linked to Russia. Hence, Russian military planners had knowledge about the grid and its critical points [44]. Reactive measures to maintain electricity during the winter 2022/2023 included establishing supply chains of spare parts, tools, cables, generators, and more from allies to minimise the negative consequences of Russian cruise missiles and drones targeting power infrastructures. Whereas proactive measures taken before the 2023/2024 winter includes deployment of advanced surface-to-air missiles at critical points, dispersion of 200.000 metric tons of sand and 300.000 metric tons of concrete to protect physical entities [44], long-term investments in de-centralised energy sources such as solar parks and windmills, as well as establishing permanent links with European power companies [45].

Applying a psychological approach to resilience acknowledges that the ability to access a working material infrastructure is closely related to the skills, motivations, and values of those individuals, teams, and organizations that protect and maintain the material infrastructure. This social infrastructure is “the number and the qualities of people in the market economy characterized by the division of labor with reference to their capabilities to contribute to the increase of the level and the degree of integration of economic activities” (Jochimsen, 1966, p. 133, cited in Torrissi, 2009, p. 11 [41]). The social infrastructure includes the motivations of the working population, the extent of learning by doing, social status and professional image, and reaction to the given degree of freedom of economic activity [42]. We foresee that in most countries the social infrastructure in war will differ from that in peace. As observed in Ukraine, when workforce is called out for military duty or temporarily leave the country, access to workforce with formal training becomes complicated. Instead, positions are filled with people that can be said to have a psychological resilience motivated by a desire to protect one's family, neighborhood, and country.

Moteff et al [40], when defining infrastructure, points to the need of a smooth functioning of government at all levels, a property also reflected in the NATO baseline

requirements. Assured continuity of government and critical government services touches the very core of a nation; its ability to function as an administrative unity. The nation's institutional infrastructure forms the framework within which its citizens can formulate their own economic plans and carry them out in co-operation with others, as explained by Torrissi (pp. 11–12) [41]. The institutional infrastructure constitutes the social integration of values and is the object of the economic and legal order within a given structure. A nation's legal constitution includes regulations on the types of government tasks and on the distribution of these obligations to different institutions of the state. Government tasks determine the organization and management of the public sector [42].

The first NATO baseline requirement is meant to ensure that the nation's institutional infrastructure is functioning. The importance of this was clearly demonstrated by president Zelensky at the very beginning of the all-out war on the 24. February 2022, being quoted on ‘I need ammunition, not a ride’ [46]. The presence and visibility of a state head and the continuing focus on state governance also under a war is paramount for the State legitimacy towards its own population and its partners and allies abroad.

Combining the robustness of the different infrastructures and responsiveness of those resources that maintain the infrastructures make up the nation's infrastructure resilience. Understanding the different infrastructures involved and their dependencies and interdependencies would add knowledge about what creates robust and resilient societal infrastructures during war.

A tentative framework for studying societal resilience. A society is a socio-economic system of socio-economic systems. We believe that studying societal resilience merely at the societal level is insufficient and that we must study it at the levels of its constituent parts. Clearly, the four levels of analysis building on ideas from psychology resilience are relevant to study resilience at the societal level. However, we think that in order to create a framework for studying societal resilience, we should combine it with ideas from engineering and ecological resilience.

In this paper, we define societal resilience as the ability of individuals and teams, organisations, networks and societies, separately and as a whole, to prepare for, respond to, resist, recover from and adapt to, major disruptions. We consequently include elements from engineering, ecology and psychology in the definition.

Consequently, we suggest the following preliminary framework for studying societal resilience. In line with Mintzberg and Waters (1985) [47], in Table 1 we add emergent strategies to the framework, since we do not believe that intended strategies are the only strategies that are realised.

Conclusions and recommendations. After the ending of the Cold War, many nations capitalised on the peace dividend and made reductions of civil preparedness and military

capability. Because of the Russian war in Ukraine, societal resilience is again at the centre of attention in many nations. The Ukrainians have demonstrated examples of remarkable resilience, from the individual to the societal level. The war also illustrates the interconnectedness of military-civil and public-private resources, the dependency on functioning supply chains and critical infrastructure, and that the aggressor targets them all. Clearly, researchers must study all these aspects of societal resilience simultaneously.

Table 1

A tentative framework for studying societal resilience

Level of analysis	Type of intended deliberate strategy		Emergent strategy
	Proactive strategies	Reactive strategies	
Individuals and teams	For responsiveness	For responsiveness	For responsiveness
	For robustness	For robustness	For robustness
	For resilience	For resilience	For resilience
Organisations (companies and authorities)	For responsiveness	For responsiveness	For responsiveness
	For robustness	For robustness	For robustness
	For resilience	For resilience	For resilience
Networks (supply chains and infrastructure systems)	For responsiveness	For responsiveness	For responsiveness
	For robustness	For robustness	For robustness
	For resilience	For resilience	For resilience
Sectors, national and supranational	For responsiveness	For responsiveness	For responsiveness
	For robustness	For robustness	For robustness
	For resilience	For resilience	For resilience

Previous resilience research has focused on subsets of the overarching system. As an example, researchers in supply chain management often focus on individual companies to study resilience, with the apparent risk of sub-optimisation. In addition, as far we are aware, there has been little focus on emergent strategies. In this paper, we take a holistic view on resilience for further research into the logistical aspects of warfare. By combining constructs from three different areas of resilience research, and adding aspects from strategy research, we develop a tentative framework for studying societal resilience, including aspects of responsiveness, robustness and resilience at different levels.

As a next step, we suggest that researchers use the tentative framework to study societal resilience in Ukraine. Clusters of research questions that researchers could address include “To what extent have Ukraine lived up to the seven baselines for national resilience?”, “To what extent have individuals, organisations and networks used proactive, reactive and emergent strategies to achieve responsiveness, robustness and resilience, respectively?”

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Стійкість суспільства в теорії та практиці

Анотація

З моменту створення НАТО, інші країни не можуть атакувати територію Альянсу відповідно до акту війни, тоді як Україна зараз переживає найжорстокішу війну на європейській землі з часів Другої світової війни. Російська війна в Україні ілюструє чотири загальні оперативні вимоги до будь-якої військової сили: доступність, готовність, мобільність і стійкість. Жодна військова логістична система сама не може задовольнити всіх експлуатаційних вимог. Логістична система залежатиме від функціонування системи інфраструктури для забезпечення мобільності, а також використовувати комерційні ланцюжки поставок для забезпечення стійкості. Базові вимоги НАТО, викладені в статті 3 Договору НАТО, які стосуються стійкості, як до систем інфраструктури, так і до ресурсів і ланцюгів поставок держав-членів. У статті визначено, що соціальна стійкість є здатність окремих людей і команд, організацій, мереж і товариств, окремо та в цілому готуватися, відповідати, протистояти, одужати та адаптуватися до основних викликів. Також розглянуто функціонування елементів інженерії, екології та психології.

Поєднуючи конструкції з трьох різних областей дослідження стійкості, і додаючи аспекти дослідження стратегії, розроблено орієнтовну основу для вивчення стійкості суспільства, включаючи аспекти чутливості, міцності та стійкості на різних рівнях.

У статті викладено перші кроки до створення основ для подальших досліджень логістичних аспектів ведення війни в контексті стійкості суспільства. Як наступний крок пропонується використання основ для дослідження стійкості суспільства в Україні. Також у статті розглянуто можливість досягнення семи базових показників національної стійкості, організація та мережі використання стратегії швидкого реагування на загрози для досягнення оперативності, надійності та стійкості держави.

Ключові слова: інфраструктура; логістика; НАТО; російсько-українська війна; стійкість, ланцюг постачання.