

Driving Innovation in Times of Crisis

CASE STUDY

Ukraine Armed Conflict

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Introduction

Societies continue to grapple in a world filled with crises, ranging from climate change and extreme weather events to high inflation and rising cost of living, energy and food insecurity, as well as armed conflicts and critical infrastructure cyber-attacks. In sum, crises have become a constant, and learning to navigate turbulence is a highly valued competitive differentiator.

In 2022, the GFCC and its member, the Japan Science and Technology Agency (JST), started a new initiative called **Driving Innovation in Times of Crisis (DITC)** to deepen the understanding of crises and facilitate innovation and prosperity in adversity.

Through a series of activities and research products, the DITC aims to develop actionable recommendations to empower businesses, governments, and organizations to thrive in instability and unlock new opportunities for innovation and prosperity.

In April 2022, during an exclusive meeting, our members and fellows chose three case studies that were relevant to our community and needed in-depth analysis. Those were the 9/11 terrorist attacks, the COVID-19 pandemic, and the ongoing Ukraine armed conflict.

We are proud to present in this document an investigation of the Ukrainian crisis. Through this case-study, we wanted to identify the history of the conflict and its cascading consequences, besides outlining the innovations arising from the situation and the new solutions that are needed.

We thank Dennis Ilnytsky, professor at Kyiv National Economic University, for conducting academic research for this document.

Finally, we thank our esteemed member JST for the inspiration, support, partnership, and funding throughout the initiative.

We are proud to present this case study in the Ukrainian crisis, and we hope you find it useful.

Crisis and Innovation: The Ukraine Armed Conflict¹

Over the past 7000 years, Ukraine has been a crossroads for 40 civilizations, each leaving its mark through times of crisis, shaping the culture and lifelong priorities of its people. The current crisis in Ukraine has deep historical roots, spanning at least 370 years of forced dependence. In recent history, Ukraine has grappled with constant instability and a lack of development, with the most recent crisis stemming from the Russian invasion. In this report, we offer insights into Ukraine's complex mosaic of modern life. We specifically address key components of Ukraine's national innovation system.

Even before the Russian invasion, Ukraine faced multiple crises, including long-term demographic and employment challenges. The growing influence of oligarchs led to societal polarization and eroded trust in social capital. These issues affected public services, economic development, and unity.

The war exacerbated these preexisting crises, creating an endless list of national challenges, with the security crisis cascading into a poly-crisis. This encompassed the disruption of daily life, information chaos, economic stagnation, infrastructure damage, population displacement, energy shortages, educational setbacks, environmental degradation, loss of life, information warfare, and food shortages, among others.

Ukraine faces the arduous task of overcoming this poly-crisis. Its foundation lies in unresolved post-Soviet issues compounded by contemporary dangers such as corruption and ineffective policies. This report provides a few examples of how Ukraine can be transformed through a "build back better" approach, aiming to counteract pre-invasion crises and construct a more resilient future.

The shock of the 2022 Russian invasion has ignited national solidarity and is poised to attract foreign attention and investment, both during the war and once the conflict concludes. A fresh start creates an opportunity to overcome entrenched interests. Contemplation amid adversity, a critical appraisal of the past and present, and the desire to construct a better future have given rise to newfound hope.

¹ It is important to note that this report is written from the perspective of the Ukrainian side of this war. It will examine situations, risks and consequences for Ukraine's society and organizations only.

Crisis Landscape in Ukraine

Brief Historical Overview

The crisis in Ukraine has deep historical roots, with various factors contributing to its complex evolution. Historically, Ukraine was a melting pot of diverse cultures, religions, and nationalities living in harmony. Ukrainian territory and its borders have been the target of ongoing conflicts and disputes that, in many cases, remain unresolved and are a continuous source of tension. A turning point occurred when Ukraine became part of the Russian Empire, leading to tensions and inequalities among its people. Ukraine's struggle for independence began in 1991, but its transition from a post-Soviet republic to an independent state was hindered by several factors, including a lack of a clear vision for its future, ineffective governance, and challenges in adapting to global trends.

Political Landscape: Ukraine saw the emergence of numerous political parties in the 1990s. Internal fights for power and corruption have resulted in lack of trust from the international community and prevented inflow of investments from abroad. The transition from the Soviet republic into an independent nation, became a long and stagnant process. The Orange Revolution in 2004 (First Maidan Revolution) and the Revolution of Dignity in 2013 (Second Maidan Revolution) marked significant moments in the country's political evolution.

Economic Challenges: Before its independence from the USSR in 1991, Ukraine's economy was concentrated in natural resource extraction and manufacturing and mostly served the needs of the Russian Federation supply chain. Over the past three decades, Ukraine faced the challenges of physical access to European and Asian markets, as well as the challenges of an underdeveloped information economy. Despite some economic transformations in labor, capital, land, information, and entrepreneurship, Ukraine has struggled to keep pace with global economic advancements, pushing its companies into low technology and low value-added sectors.

Demographic Decline: Ukraine's demographic decline has been a persistent challenge, resulting in a loss of over 20 percent of its population over the period from 1991 and 2021. This decline has impacted the country's creative class, particularly researchers, which has serious implications for its future.

Information Society: Ukraine's transition to an information society began in 2013, way behind developed countries. Although the country had significant advancements in telecom and mobile network after the 2000s, the lack of strategies and investment, this sector of the economy is dominated by foreign hardware suppliers and an oligarchic media sector generating challenges in development and digital divides. Ukraine boasts a skilled IT workforce but struggles to retain talent due to more attractive jobs offered by foreign companies. In 2022, the Ministry of Digital Transformation estimated that Ukraine had 250,000 remote workers and half of those worked for non-Ukrainian companies.

Innovation Ecosystem: Competitiveness and innovation ecosystems are still rarely discussed by Ukrainian government institutions. Besides underinvestment in innovations, other challenges faced by the Ukrainian innovation ecosystem are the lack of interaction between academia, government and businesses, an unclear national technological policy, and low effectiveness of state-led instruments to support innovation activities.

In summary, Ukraine's crisis is a multifaceted issue deeply rooted in its history, politics, economy, demographics, and societal changes. Addressing these challenges requires a comprehensive and sustained effort to build a stable and prosperous future for the country.

The Poly-Crisis and its Threats

Short-term reactions to the challenges of warships prevail in Ukraine now. Safety and defense are the key factors under discussion every day. Mid- and long-term issues are out of agenda as they highly depend on the longitude and results of the war. However, some strategic thinking could be found, which includes development of innovations.

Before 2022, Ukraine had been engaged in an eight-year hybrid war with the Russian Federation, resulting in exhaustion across various dimensions such as occupied territories, material resources, lost foreign direct investment (FDI), and inadequate budgets for growing security needs. This led to reduced financial support for national systems, including science and education. Ukraine's innovation activity was largely left to evolve on its own, with a 2021 Bloomberg Innovation Index ranking it 33rd among the top 50 economies, mainly due to its education system and patenting activity, but lagging in manufacturing, R&D, hi-tech companies, and research personnel.

Ukraine's management style in policymaking often lacked input from stakeholders such as universities, leading to unclear targets and the absence of key performance indicators (KPIs). Additionally, weak environmental management in industrial regions was exacerbated by the war, resulting in ecocide. The growth of corruption and increasing oligarch influence, before the Russian invasion, has led to unstructured markets and weak investment climate, just to name a few of its consequences. The country's shadow economy was significantly larger than the global average, attracting multinational companies to Russia instead of Ukraine.

Ukraine's Global Innovation Index ranking declined from 45th in 2020 to 57th in 2022, mainly due to weaknesses in market sophistication, institutions, and infrastructure. The ongoing war strained the country's budgets, potentially reducing per capita expenditures in education, research, and social support, challenging social and economic development but emphasizing the importance of innovation.

Despite these challenges, Ukraine was recognized as a country that makes significant contributions globally to Science & Technology¹ relatively to its size (measured in GDP). However, the country often didn't receive credit for innovations that started within its borders (i.e. the development of parts of the Mercedes Benz navigation system by Navteq). This discrepancy was attributed to emerging or immature institutions that operated without a focus on improving the quality of life in Ukraine or enhancing competitiveness.

Demographic Issues

Since 2022, Ukraine has been facing a wider range of demographic challenges, including additional deaths caused by war, internal migration, and exodus, a low birth rate, and inadequate healthcare. These issues, compounded by the loss of territories and the deportation of people and children recognized as genocide by PACE, have put Ukraine at risk of a demographic catastrophe. The World Bank estimates that 7.1 million people will fall into poverty, with unemployment reaching up to 36 percent in 2022.

The long-term impact on Ukrainian culture and values will depend on the resolution of the conflict, and while the possibility of returning migrants exists, it remains uncertain. In order to avoid these challenges, as well as mitigate potential losses of GDP due to population decline, the Ukrainian government should address these challenges through migration policy, national identity, security, education, and enhanced living conditions (for example, better health care). Ukraine may become a hub for tourism, business, and volunteerism in the future, but capacity limitations in the hospitality sector may pose challenges.

Social Instability

Social stability plays a critical role in a country's defense capability, and wartime governance must focus on fostering social cohesion and solidarity. During the early stages of the aggression in Ukraine, many state and regional bodies faced workforce shortages, leading to self-organization efforts by people in cities and regions. City and regional managers have since used social media to engage with and inform the public, enhancing social capital and facilitating effective communication. National information platforms, such as air-attack alert systems and visual search tools for drones and missiles, have further connected people to a common goal, countering attempts to divide the nation.

¹ According to The Good Country Index (www.goodcountry.org) that measures how much each country on earth contributes to the planet and to the human race, relative to its size (measured in GDP).

The significant population migration in 2022, comprising women, children, and the elderly, presented logistical and service challenges in areas like food production, delivery, and communal services. The banking sector coped well due to prior online service development, while state social service providers maintained control through digitalization and cloud platforms. The stress on the labor market, larger than Germany faced in World War II, must be compensated for with traditional and innovative tools, including better work terms, increased inclusiveness, easier distance work, and an attractive open migration policy.

The state has also taken steps to combat misinformation and propaganda, unifying key TV and radio channels on a common platform to provide reliable information. The creation of a Center for Countering Disinformation under the National Security and Defense Council of Ukraine illustrates effective cooperation among state bodies in countering disinformation, with a focus on innovative techniques in cybersecurity. The nation has united around defense priorities, reflected in state and local budget allocations for social and defense spending, with political activity limited to discussions of current needs and expert discussions in specialized areas. Trust in government has improved since the active fight against corruption began in 2022, with surveys indicating increased trust in state bodies, the army, and volunteers, as well as a sense of optimism about the future.

Weakened Innovation Ecosystem

Institutional development and the balance of powers in Ukraine have been areas of ongoing reform since 2014, with numerous changes aimed at improving governance and economic systems. These reforms have touched upon decentralization, fiscal discipline, budget processes, macroeconomic stability, the banking sector, public procurement, police, army, and land markets. Market-oriented reforms are expected to address monopolies in various sectors. However, the judiciary system faces challenges in terms of public trust and property protection, requiring a strategy for improvement.

Decentralization reform initiated in 2014 is still in progress, with the COVID-19 pandemic and war posing obstacles to its full implementation. The split of powers, tasks, and resources between local and central authorities necessitates further efforts to achieve effective distribution. While some institutions are actively pursuing reforms, others lack the necessary political will. This situation has left regional innovation ecosystems underdeveloped, creating opportunities for the growth of industrial, institutional, and national innovation ecosystems.

The development of innovation ecosystems in Ukraine has seen self-organization processes, with clusters forming in various sectors since the mid-2010s. However, corruption and inadequate state management have challenged the attractiveness of these clusters. To thrive both domestically and globally, clusters have begun forming associations, such as the Association of Innovation-Space Clusters and the Ukrainian Cluster Alliance, receiving support from international partners like the **Deutsche Gesellschaft für Internationale Zusammenarbeit** to enhance the diversity of international ecosystems.

Risks to the Economy

The dynamics of Ukraine's GDP are highly susceptible to external shocks and global economic cycles, given its strong reliance on international trade and external markets. This dependence has been exacerbated by a lack of internal resilience. To stabilize the exchange rate of the Ukrainian hryvnia (UAH) due to limited liquid reserves, the government and the National Bank of Ukraine have often opted to devalue the currency. However, since 2013, the Ukrainian government has shown an increased ability to learn from past mistakes and manage potential risks, which helped mitigate the impact of the COVID-19 pandemic. Additionally, Ukraine received generous external support after the resumption of hostilities in 2022, enabling the country to maintain exchange rate stability with minor fluctuations.

In 2022, Ukraine experienced a significant decline in business activity, with a notable drop in the Business Activity Expectations Index. This decline was attributed to the extraordinary challenges brought about by the war, leaving businesses focused on survival. The index began to recover in April 2023, reaching a positive level of 51.5 percent, with trade and industry sectors showing optimism while services and construction remained pessimistic. The Ukrainian Business Index also experienced a downturn in late 2021 but had since recovered to 30.76. The pandemic led to innovation in some sectors, such as the rapid assembly of modular houses and the emergence of a new sector in the real estate market focused on the reconstruction of old houses to accommodate individuals leaving cities for remote work or those displaced by the conflict. Moreover, initiatives like the construction of the largest school in the Lviv region using 3D printing technology highlight innovative approaches to addressing challenges.

Additionally, international investment positions in Ukraine achieved greater equilibrium between assets and liabilities in 2022, driven by a decrease in total liabilities and an increase in total assets. Major changes in liabilities included long-term loans, direct investments, trade credits, and advances, while currency, deposits, and debt securities were significant contributors to asset growth.

The ongoing war, along with the substantial damages caused by the aggressor, has prompted discussions about nationalization or asset confiscation from Ukraine's wealthiest individuals, given their role in both Ukraine and Russia. A registry of Russian-owned assets in Ukraine is being compiled by the Ministry of Justice. Ukrainian businesses have also actively supported national defense efforts, with major oil extracting and processing companies, UkrNafta and UkrTatNafta, placed under government control to ensure stable fuel supply. Ukraine's agriculture sector has emerged as a significant player in the international food market over the past decade, driven by better-structured internal markets, some innovations, and exploration of niche markets abroad. While the official agricultural land market began to take shape in 2021, the sector faces challenges from ecocide, capital constraints, stolen harvests, land under occupation, and damaged infrastructure, likely impacting the sector's performance this year.

Ukrainian Businesses Amidst Crisis

In 2022, businesses in Ukraine undertook initiatives that connected them more closely with their local communities. Many Ukrainian companies, along with their owners and employees, engaged in philanthropic efforts by providing humanitarian aid such as food, goods, and shelter, as well as military support to the army and municipal self-defense forces. This newfound approach to building a valued brand through humanitarian efforts is likely to continue even after the war. Corporate responses to the crisis also included the construction of a railway hub in the Lviv region to connect Ukrainian and European railways, a project expected to last 1-5 years, as well as new cross-border logistics projects.

Ukrzaliznytsia, Ukraine's railway monopoly, adapted to the security challenges posed by missile attacks on railway infrastructure in Khmelnytsky and Ternopil regions in May 2023. Trains were temporarily prohibited from passing through these areas, prompting Ukrzaliznytsia to swiftly review its route network and coordinate with local transport providers and foreign railways. The company used social media, national TV, radio broadcasts, and innovative targeted navigation notifications to inform passengers about the situation and provide assistance, a mechanism initially planned for later implementation but now indispensable in urgent situations. Positioned at the core of the transport infrastructure, Ukrzaliznytsia envisions becoming a hub by connecting with stations, airports, bus and taxi companies through active IT synchronization.

The need for innovation is evident in the reconstruction of damaged infrastructure to make it sustainable, green, and resilient, alongside regulatory reform efforts. However, corporate leaders may not always recognize the range of possibilities for innovation due to capital constraints and limited connections with innovators and universities. The current juncture represents an opportunity for strategic and immediate priorities to converge, requiring compromise to shape better scenarios for the future.

Innovation in the Context of the Crisis

Looking Ahead: Steps to Overcome the Crisis

Since Russia's military aggression and occupation of Ukrainian territories in 2014, Ukraine has effectively been in a state of war. The recognition of a crisis became a political matter, primarily manifesting in declarations and policy documents. For many (statesmen and political personnel) the task was to counter-act and prepare for an aggravation. For others it was time to focus on survival and peaceful development.

A critical factor enabling Ukraine to endure and resist since 2022 lies in its strong national identity and unity, formed over centuries of foreign occupation and oppression. Other key factors include institutional maturity and effectiveness, decentralization reforms, international support, efficient utilization of grants, credits, and investments, weapons inventory and newly acquired competencies, and a better understanding of Ukraine's situation. The country's size in terms of economy, territory, and population made it challenging to conquer it in just a few days. This combination allowed Ukraine to manage the crisis, respond to significant challenges, and maintain hope for a brighter future. Efforts to clean up institutions and security apparatuses after 2014 played a crucial role in recognizing and preparing for dangers, including cooperation with various NATO institutions.

Previous digitalization initiatives became valuable during the war, facilitating remote communication and digital banking, as well as encouraging e-commerce and enhancing postal services. The widespread use of social media and mobile devices kept the population informed and aware of potential dangers.

After the war, the devastated economy will make Ukraine's crisis more apparent. Consequently, preparations for recovery are already underway. Innovation criteria have been introduced into the assessment framework for rebuilding the state, following recommendations from the Boston Consulting Group and the European Investment Bank.² The Ukraine Recovery Plan³ is being discussed among the President, Verkhovna Rada (Parliament), Cabinet of Ministers, and Ministry of Digital Transformation. It encompasses various national programs with key priorities:

- Recovery and upgrading of housing and regional infrastructure (approximately \$250 billion).
- Logistics optimization and integration with the EU (approximately \$160 billion).
- Achieving energy independence and Green Deal goals (approximately \$130 billion).
- Ensuring competitive access to funding (approximately \$75 billion).
- Securing macro-financial stability (approximately \$80 billion).
- Growth of value-adding sectors of the economy (approximately \$50 billion).

² "Supporting Ukraine: A Study on Potential Recovery Strategies for Ukraine", Boston Consulting Group (BCG) and European Investment Bank, January 2023, Accessed on Sep 28, 2023, <https://media-publications.bcg.com/Supporting-Ukraine-Potential-Recovery-Strategies-Feb-2023.pdf>

³ Note that the estimates below were last accessed in September of 2023 through the link: <https://recovery.gov.ua/>

- Strengthening defense and security (approximately \$50 billion).
- Rebuilding a clean and safe environment (approximately \$20 billion).
- Recovery and modernization of social infrastructure (approximately \$35 billion).

Planning development steps can be beneficial. Ukraine's administrative model from its Soviet era has honed planning skills and these are complemented by survival and progress in resource-scarce scenarios. Various state bodies are engaged in designing the Recovery Plan within their respective domains, such as the State Agency for Reconstruction and Development of Infrastructure, responsible for transport infrastructure.

Addressing Threats to Future Recovery

The ambitious effort to rebuild Ukraine's economy faces a significant obstacle: the limited capacity of its innovation system. Key challenges include a lack of experience handling substantial funding, inadequate emphasis on effectiveness management, and insufficient institutional diversity and autonomy.

Post-war recovery and development will demand a range of resources, including financial and long-term capital. Modern open innovation ecosystems should accelerate technology catch-up, mitigating the risk of decades-long delays. While the war may spur innovation in weaponry, resources should also be allocated to peaceful technologies. Massive urban and rural rebuilding, incorporating new green and digital standards, will be essential.

Innovation has not been a central focus in Ukraine's political process. Investments primarily flow into fields with proven efficiency globally. Building an entrepreneurial culture nationwide is imperative. However, fostering an entrepreneurial ecosystem requires more than this; it involves people, policy, funding, culture, markets, and support infrastructures, all interconnected. The development of a genuine culture of competition, including a security dimension, deserves special attention from both the state and markets.

Ukraine needs to cultivate a variety of innovation ecosystems, including national, regional, industrial, institutional, and corporate ones. This should encompass the incorporation of modern concepts into policy decisions, aligning with limited industrial priorities. Green and digital transformations should pave the way for entrepreneurial and innovation ecosystems to transition into a social economy ecosystem.

Existing institutions like the Ukrainian Startup Fund, State Finance Institution for Innovations, and National Research Foundation of Ukraine need institutional maturity, resources, and stronger links and tools. However, universities remain underrepresented in policy development, hindered by a lack of autonomy, resources, and the means to fully leverage their potential for national and regional development.

The integration of Ukraine's economy into the global arena remains a work in progress. Ukraine has been isolated from global value chains and many international processes such as politics, culture and sports. Ukraine social and economic development requires higher acceptance and integration into the global economy.

Institutions and ethics, crucial during war, must be equally valued in peace. Corruption undermines justice, reducing incentives for investment and innovation. Improved social governance and solidarity should be among the post-war outcomes.

The myriad challenges facing Ukraine require recognition and concerted efforts across social, economic, informational, ecological, and value chain dimensions. Establishing a platform for discussing key dimensions and strategies to build a better future is essential.

Shaping the Innovation System

Ukraine will have a myriad of needs for innovative solutions to overcome challenges, rebuild and modernize its economy, foster development and prosperity, while becoming a more resilient society.

Ukraine's improvement and innovation needs span multiple fields, including:

- Enhancing road and infrastructure quality.
- Promoting a circular economy and advanced waste management.
- Developing modern machinery, especially in agriculture and robotics.
- Elevating the culture of state governance.
- Implementing modern approaches to connect government, business, and academia.

External demands, from institutions like the IMF and the EU, urge Ukraine to innovate and become more effective and modern in areas like taxation, tax management, state governance, and labor relations. However, discussions about the broader development of innovation ecosystems are scarce. Ukraine's integration to the EU has immense value as it would bring more support to its economic development and better integration to the global economy, including joint research and education and inclusion into the European innovation ecosystem.

Cities, as the foundation of regional ecosystems, vary in their readiness to host innovation ecosystems and support innovation activities in Ukraine. Regional leadership culture is an essential component requiring development in the short and long term. Ukraine highly values cooperation between its regions and cities, along with foreign counterparts, many of which provide humanitarian assistance. Foreign cities that offer substantial support to Ukrainian citizens, forced to leave due to Russia's attacks, are recognized as "Rescuer Cities." So far, seven cities from Poland, the Czech Republic, Lithuania, and France have earned this honor.

Establishing a National Competitiveness Council in Ukraine could serve as a valuable institutional step. This council would aid the President and other state bodies in making well-informed decisions, coordinating strategic development, and integrating them into the national competitiveness framework.

Innovations in Ukraine: A Glimpse of Hope

In times of crises and conflicts, innovation thrives as the urgent demand for novel solutions becomes unmistakably clear. These challenging moments serve as catalysts compelling individuals, organizations and societies to rethink the established norms and embrace creative problem-solving. While many innovations address pressing issues like security and food supply chains, Ukraine has witnessed diverse innovations during these challenging times, spanning institutional, sectoral, and nationwide realms, some of which have the potential to become world-class innovations.

In the following sections, we present a few cases of innovative efforts driven by the recent crisis in Ukraine that have the potential to shape the future of Ukraine.

Focus on Cybersecurity

Crisis Recognition

The crisis began on January 14, 2022, when Ukraine claimed the top spot in cyber-attacks, surpassing the USA, which had held second place for a considerable time. A digital war began for IT specialists, commencing 40 days before any land invasion. In the initial month of the 2022 invasion, cyber-attacks surged threefold compared to the same period in 2021. This onslaught of cyber-attacks was an example of a new type of warfare and a change in the potential future of warfare.

The Crisis and its Dangers

Cyberattacks and cyber warfare are ongoing threats that Ukraine has been dealing with since the late 1990s but have continued to evolve with the advancement of technology. Although these are constant threats, the crisis began before the physical land invasion of Ukraine. The initial stage of the war saw a dramatic increase in cyber operations.

Ukraine's Computer Emergency Response Team (CERT-UA) has been active since 2007. CERT-UA, the national team responsible for responding to computer emergencies, dealt with approximately 7,000 cases in 2022, and this trend continues into the current year. They have identified a recurring pattern in cyberattacks and have outlined several key phases of modern cyber warfare:

- Pre-January 14, 2022
- After January 14, 2022, and during the first month of the land invasion (including attacks on state institutions, DDoS attacks, breaches of the Viasat satellite network, and other media)
- Since the end of March 2022 (characterized by more sophisticated attacks on major infrastructure systems, such as the national telecommunications operator and the Ministry of Foreign Affairs)
- From autumn 2022 (shifting focus towards energy systems, often accompanied by missile attacks)
- Since January 2023 (involving espionage for sensitive data and targeting supply chain institutions like logistics, platforms, IT providers, and software developers).

This progression highlights the evolving nature of cyber threats.

Since Ukraine boasts one of the world's most dynamic and rapidly growing IT sectors,^{4,5} some specialists can predict and communicate the need for recognizing cyber threats to national defense, which greatly aided Ukraine in reducing the damage of Russia's cyber-attacks. This capability has enabled proactive measures against cyberterrorism, even during periods of resource scarcity. Ukraine's cyber defense mechanisms have been critical in its ability to thwart Russia's aggressions.

Hazards of Inadequate Response

To understand the dangers of cyber-attacks, it's important to categorize different types into groups, with phishing being the most prevalent as both a technology and a component of larger cyber processes. One notable trend involves distributing cracked software containing trojan viruses for free downloads. CERT-UA has also identified a typology of cyber-aggressors, including military hackers, cybercriminals, and hacktivists, currently targeting Ukraine. Consequently, this has resulted in prohibiting and blocking Russian-made software, social media platforms, and even certain internet sites.

Response and Innovations

In response to a significant increase in cyber-attacks and the bombing of one of Ukraine's backup data centers, Ukraine had to make substantial changes to its architecture. This required relocating numerous national systems, registers, and data centers from the capital to various locations within Ukraine and abroad. However, with profound implications for Ukrainian sovereignty, a groundbreaking decision was made to transition many of these systems to the Cloud and develop a unified national platform for all registers. This initiative received strong backing from the Parliament of Ukraine, as well as support from tech giants like Amazon, Microsoft, and Google. Furthermore, several other countries have agreed to officially recognize Ukrainian e-documents.

CERT-UA gathers information from various sources to assess the situation, including input from affected users, cybersecurity experts, cyber intelligence, and international partners such as the global FIRST community, the U.S. national CISA, and Microsoft. Additionally, as of May 2023, Ukraine has joined as a contributing participant in NATO's CCD COE.

In 2022, CERT-UA had to make legislative adjustments to enable collaboration with private businesses. This involved establishing requirements, conducting cyber system audits, and offering various services. Consequently, it's not just government

entities but also private ones that fall under the oversight of this state institution. One of the latest decisions has been to enhance national and corporate cybersecurity by initiating the development of industry-specific Security Operation Centers (SOCs).

Focus on Defense Technology

Crisis Recognition

The 2022 Russian invasion of Ukraine was immediately recognized as a crisis by the international community. On February 24, 2022, the day of the invasion, the United Nations Security Council held an emergency meeting to discuss the situation. The meeting was unable to reach a consensus on a resolution condemning the invasion, due to Russia's veto power. However, the vast majority of member states spoke out against the invasion, and many called it a crisis.

The Crisis and its Dangers

The 2022 Russian invasion of Ukraine is a serious crisis with far-reaching implications. It has caused widespread death and destruction, and it has displaced millions of people. The invasion is a clear violation of international law, and it has raised concerns about the willingness of Russia and other authoritarian states to challenge the rules-based international order.

In addition to the immediate humanitarian and economic crisis, the 2022 Russian invasion of Ukraine has also been recognized as a crisis for the international order. The invasion is a clear violation of international law, and it has raised concerns about the willingness of Russia and other authoritarian states to challenge the rules-based international order.

Hazards of Inadequate Response

It is difficult to say with certainty what would have happened if Ukraine's defense and military did not respond quickly and effectively to the Russian invasion in 2022. However, it is likely that Russia would have been able to achieve its objectives, which included the overthrow of the Ukrainian government and the installation of a pro-Russian regime. This would have had a number of negative consequences for Ukraine, including:

- The loss of Ukrainian sovereignty and independence
- The imposition of a repressive Russian-backed government
- The suppression of Ukrainian culture and identity
- The exploitation of Ukraine's natural resources by Russia
- The displacement of millions of Ukrainians

4 "The growing IT sector in Ukraine", BBC Future, accessed on October 2, 2023, <https://www.bbc.com/storyworks/future/ukraine-innovating-for-the-future/ukraines-dynamic-it-sector>.

5 "Ukraine IT Report 2021", IT Ukraine Association, accessed on October 2, 2023, <https://reports.itukraine.org.ua/en>.

Response and Innovations

The foremost priority recognized by Ukrainian authorities is security, encompassing the entire spectrum of national defense instruments. In 2023, a groundbreaking initiative called BRAVE1⁶ was unveiled as a specialized cluster dedicated to advancing Defense Tech.

Ukraine manufactures a series of military equipment, including armored vehicles, tanks, self-propelled artillery installations, drones, and anti-tank missile complexes, all of which hold significant potential to secure competitive positions on international markets. However, the full-scale production of these advanced weapons is still in progress, influenced by a multitude of factors.

The development and implementation of BRAVE1 is a collaborative effort under the unprecedented oversight of multiple governmental entities, including the Ministry of Economy, Ministry of Defense, Ministry of Digital Transformation, Ministry of Strategic Industries, along with the National Defense Council and the General Staff of the Armed Forces of Ukraine.

The unique design of this cluster categorizes it as a specialized innovation ecosystem, offering inventors and researchers substantial financial, informational, and organizational support aimed at achieving technological supremacy in the field of Defense Tech. Over the past nine years, the Defense Tech sector in Ukraine has witnessed active growth and has accumulated extensive practical experience. As a result, the BRAVE1 ecosystem now provides:

- Evaluation of technology readiness and acceptance for military applications, encompassing military expertise, presentations to military consumers, hackathons to tackle military challenges, field demonstrations, troop testing, and integration into active service. Bloomberg has even referred to Ukraine as "a proving ground for startups looking to showcase their latest technologies."
- Project financing and scaling opportunities, including grant support, investment attraction, business scaling support, access to accelerators and incubators, the establishment of an R&D resource center, and participation in international exhibitions and presentations.
- Business education programs, such as business acceleration for development and scaling, workshops, masterclasses, networking events, and meetings.

- Legal support services for the formalization of developments, consortium creation, adherence to national and NATO standards, and the legal safeguarding of intellectual property rights.

In addition to these initiatives, Ukraine has recently initiated several groundbreaking projects in the realm of Defense Tech. Notable examples include solid fuel engines developed by the Promin Aerospace team,⁷ various types of unmanned aerial vehicle engines, smart tokens by TEMB Military,⁸ land robotics innovations by Roboneers,⁹ and the utilization of artificial intelligence for security needs by Griselda,¹⁰ among others.

Furthermore, Ukraine's accession to the NATO Cooperative Cyber Defense Centre of Excellence in 2023 marks a significant step toward integrating the nation into the broader security landscape.

Focus on State Governance (DIIA)

Crisis Recognition

This case illustrates how a combination of factors can lead to the digital transformation of state governance. It involves leveraging assets such as a strong national IT sector and a well-educated workforce while investing financial capital to address the imperative for improvements. Additionally, it recognizes the importance of tackling issues like corruption and staying aligned with the global digitalization trend.

The Crisis and its Dangers

In 2016, Ukraine joined the International Open Data Charter, setting the stage for significant advancements in state governance. These developments were well underway when the invasion occurred in 2022. In 2018, the Ukrainian government adopted a roadmap for implementing the Charter, complemented by the USAID/UK aid project on "Transparency and Accountability in Public Administration and Services" (which started in 2016 and was extended until 2024) and the E-Governance for Accountability and Participation Program funded by Switzerland from 2015 to 2023.

Hazards of Inadequate Response

Improving government transparency and accountability is critical for Ukraine to attract private sector investment and meet EU accession conditions. Digitization must be part of Ukraine's governance and transparency reforms, which should not be too challenging given Ukraine's historically strong IT sector. Without digitalization, Ukraine misses an opportunity to involve

⁶ <https://brave1.gov.ua/>

⁷ <https://prominaerospace.com/>

⁸ <https://temb-military.webflow.io/>

⁹ <https://roboneers.net/>

¹⁰ <https://www.griselda.com.ua/>

Ukrainians in the war effort. Ukraine needs to reduce corruption risks and budget expenses by streamlining processes. The government should continue implementing state-of-the-art technology to increase the country's resiliency across wartime and peacetime.

Response and Innovations

The Digital Interaction and Information Architecture (DIIA) platform offers a wide range of e-services. These include e-signatures, citizenship applications, certificates, e-documents like personal driving licenses, birth registrations, residence changes, and death certificates. The platform also facilitates tasks such as starting small businesses, accessing grants for veterans and small and medium-sized enterprises, obtaining information from state-run registers, streamlining licensing and permissions procedures for companies, reporting to government bodies, and making payments for state fees and fines. Furthermore, it supports various educational activities, including admission campaigns for educational institutions, and e-medicine services. Of particular importance for societal development is the e-democracy mechanism, which introduces tools for electronic petitions, polls, discussions of draft regulations, public budgeting, public appeals, and more.

An e-infrastructure program was essential to ensure that social facilities, villages, towns, highways, and railways are all connected to high-speed internet access (e-access).

Ukraine anticipates improved state operations through the digital transformation of state asset management. This includes the establishment of the National Center for Preserving State Information Resources, an information system for creating and managing registers, central cyber protection services (e-cyber), the development of a data bank for state statistical observations (e-observation), as well as e-assessment, e-rent, and e-privatization.

Ukraine has been eagerly awaiting the long-overdue preparation and conduct of nationwide population and housing censuses, as well as agricultural and industrial censuses (e-census) for decades.

The much-anticipated green transformation will feature the creation of an electronic system for tracking and managing natural resource usage within nature reserve areas and locations (e-nrf). This includes issuing permits for special natural resource use, import/export of wild flora and fauna specimens, certificates for mobile exhibitions, and permits for special Red Book of Ukraine object use, all in electronic format.

Furthermore, the transformation will automate strategic environmental assessments (e-sea), environmental monitoring (e-environment), environmental impact assessments, and post-project monitoring (e-EIA). It will also establish an electronic accounting system for pesticides and agrochemicals (e-pesticides), an informational and analytical module for water resource protection and rational use (e-water), electronic auctions, and the issuance of special permits for natural resource use (e-natural resources). Additionally, it will introduce an electronic system for state and public forestry control (e-forest), as well as a system for reporting, permissions, issuance, and accounting of pollutants and atmospheric air quality monitoring (e-air), and an electronic waste tracking and monitoring system (e-waste).

The implementation of electronic residency, the management of virtual assets, and the creation of a virtual economic zone (e-Economy) are currently in progress. E-residency aims to bolster IT entrepreneurship in Ukraine and is recognized as the first of its kind in Eastern Europe, reflecting the rapid changes driven by business requirements.

Other digitalization projects include, but are not limited to, the following:

- Human capital management: e-Youth, e-School, e-Stadium, e-Champion, e-Book, e-Art, e-Heritage, e-Veteran, e-Public health, e-Employment, e-Science, and e-TOT (displaced persons and persons living in temporarily occupied territories).
- Sectors of the economy: e-Tourism, e-Pilot, e-Port, e-Customs, e-Infrastructure, e-Roads, e-Carrier, e-Mine, e-Atom, e-Electricity, e-Energy efficiency, e-Energy management, and e-Energy saving.
- Business management: e-Bankruptcy, e-Consumer, and e-Products.
- State management: e-Liquidity, e-Local budgets, e-Law, e-Police, e-Notary, e-Conviction, e-Proceedings, and e-Visa.

Meanwhile, Ukraine's Computer Emergency Response Team is expanding its efforts to combat cyber warfare and thwart attempts to disrupt innovation. While it may not be flawless in all areas, the team has successfully thwarted most cyberattacks and collaborated effectively with foreign partners to address these challenges.

Focus on Kyiv National Economic University (KNEU)

Crisis Recognition

Innovations undoubtedly require financial backing, yet higher education institutions in Ukraine face limited opportunities to secure such support domestically. During a period when research and development expenditures dwindled from 1.36 percent in 1996¹¹ to a mere 0.43 percent in 2019,¹² most higher education institutions found themselves grappling with diminishing financial resources year by year. In addition to that, Ukrainian legislation has merely paved the way for the creation of endowment funds but still imposes significant hurdles on its use.

The Crisis and its Dangers

The aspiration to shift from a socialist to a capitalist, market-oriented socio-economic model was a prevailing idea among those committed to reforming Ukraine. In the 1990s, Ukraine witnessed the emergence of various new institutions, mirroring developments in larger economies. However, the effectiveness of these institutions varied due to ineffective reforms, a dearth of competencies, legal hurdles, and the reverberations of global crises. Discussions pertaining to competitiveness and innovation ecosystems remained a rare occurrence. Unfortunately, the responsibilities associated with liberalization remained underdeveloped, leading to an escalation of risks and prolonged inefficiency within the system.

Over the past three decades, Ukraine has incrementally transformed its dynamics concerning the workforce, capital, land, information, and entrepreneurship. Meanwhile, neighboring countries and global leaders have made significant strides forward. A truly global economy has taken shape, with Ukraine still endeavoring to integrate fully. A post-industrial transformation has occurred, yet the Ukrainian economy lags in certain areas. Networked value chains and competitive markets have erected fresh barriers, pushing Ukrainian companies towards low-technology, low-value-added sectors. Globally, an innovation ecosystem has developed, alongside national innovation systems in countries capable of investing in fundamental and applied research. Despite being granted market economy status by the USA in February 2006, Ukrainian strategies have rarely focused on market development, market relations, and supply-demand management.

Political uncertainty has heightened the risk of Ukraine regressing into a third-world nation and has fostered a culture of laxity. The ambition of becoming a competitive or innovative state within the international arena has seldom been earnestly debated or placed on the national agenda.

Hazards of Inadequate Response

A lack of innovation can lead to economic stagnation. Even before the Russian invasion, Ukraine was already struggling to keep up with the rapidly changing global marketplace. Its weakened innovation ecosystem can have even deeper consequences to Ukraine's future such as:

- Increased loss of competitiveness and markets
- Inability to transform the innovations that arose during the conflict into improved uses in peaceful times
- Limited industrial expansion leading to limited job opportunities and higher unemployment and reduced income levels for the population
- Loss of attractiveness for the return of Ukrainians who left the country since the invasion
- Reduced resilience as a consequence of smaller economic diversity

Response and Innovations

In an ecosystem where institutions possess a fair level of independence in setting priorities and objectives, market failures or state governance inefficiencies should not hinder the progress of innovation. Recognizing this, and building upon its limited autonomy and mission, the Kyiv National Economic University (KNEU) is taking proactive steps to address the innovation gap. Leveraging the achievements of its scientific schools, KNEU has embarked on a mission to provide master-level programs and courses in the field of competitiveness management. Notably, in 2021, KNEU unveiled a roadmap for developing human capital in the digital economy, derived from its research findings.

Nevertheless, a resilient cadre of enthusiasts and teams persists, tirelessly working across diverse fields, contributing to nationally and, at times, globally significant inventions and intellectual products. Until 2023, the national innovation ecosystem, while vibrant, lacked the requisite infrastructure to propel these innovations forward. Recognizing this gap, a team of KNEU graduates and professors, inspired by the spirit of nationwide volunteering, joined forces to create an online platform aimed at enhancing the visibility of innovations in Ukraine.

¹¹ https://ukrstat.gov.ua/operativ/operativ2005/ni/ind_rik/ind_u/2002.html.

¹² https://ukrstat.gov.ua/operativ/operativ2017/ni/vvndr_vr/vvndr_vr_u.htm.

At its core, the Innovation Ukraine platform features the "Digital Accelerator—Menu of Innovations," a digital platform offering comprehensive support for talent and innovative projects, guiding them from conception to commercialization. Its purpose is to expedite post-war recovery and foster competitive development within Ukraine. The majority of projects undertaken by KNEU align with this vision, which aspires to create a competitive nation of content and fulfilled citizens.

KNEU expresses profound gratitude for its collaboration with the Ministry of Economy and the active participation of all partners in shaping the Innovation Menu. This platform promises to unlock incredible opportunities for post-war reconstruction and the competitive advancement of Ukraine in high-tech domains. Envisaged as a pivotal component of Ukraine's Recovery and Development Plan, the Innovation Menu currently allows users to:

- Share information about their projects.
- Search for innovative projects based on various criteria.
- Foster contacts and partnerships.
- Access aggregated analytical information categorized by clusters.

KNEU harbors ambitious plans for the platform's future development, envisioning its transformation into a dynamic hub within the innovative ecosystem. This envisioned transformation includes the platform becoming:

- An open space for the exchange of ideas and collaboration.
- An expert center offering analytical support for crafting strategies and roadmaps for Ukraine's innovation.
- An institutional mediator, facilitating interaction between project initiators and stakeholders.
- A laboratory of ideas, stimulating idea generation and supporting the development and implementation of innovative projects.
- An educational center, disseminating knowledge and expertise while providing training in academic entrepreneurship.

Conclusion: Embracing Hope and Proposals

Since the Russian invasion in 2022, Ukraine has received invaluable support from countless individuals, countries, institutions, and organizations. While it's impossible to cover the entire history of this conflict and mention every effort made to overcome the crisis currently faced by Ukraine, the intention of this report was to spotlight several instances of innovation and innovative responses during these challenging times.

The losses suffered by Ukraine since the Russian invasion have been staggering. The war in Ukraine has been marked by great civilian and military losses,¹³ devastating economic losses,¹⁴ occupation of manufacturing plants, damage of homes and infrastructure, seizing of territories, and population displacement with many Ukrainians fleeing to neighboring countries. Outside Ukraine, the war has raised global food insecurity, significantly impacted European and global energy security, and certainly led to increased geopolitical instability around the world.

Even under the current situation, Ukraine needs to start a plan to drive the nation towards a better future. The sense of urgency and unity created by the war might present Ukraine with hope and even restored focus on defining priorities and measures that are more effective and innovative than past ones in revitalizing and reinventing its Economy.

Ukraine's governance model should become more active, transparent, and innovation driven. Stronger links between the academy, government and businesses are needed. National leaders must recognize that it's time to innovate in every field to demonstrate a case of smart recovery. The recent digitalization of state services and novel communication styles are among the avenues being explored.

Innovation is a crucial determinant of competitiveness and holds the key to unlocking Ukraine's potential. Inefficient investments perpetuate a lack of financial resources in science, research, and development (R&D), higher education systems, and other critical areas. An effective innovation ecosystem is essential for the successful functioning of a state, allowing the creative potential of individuals, organizations, and businesses to flourish.

¹³ As of August 4, 2023, the Office of the United Nations High Commissioner for Human Rights (OHCHR) has verified the deaths of over 9,600 civilians in Ukraine since the start of the war. The Ukrainian government has not released official figures on military losses, but the U.S. government estimates that over 100,000 Ukrainian soldiers have been killed or wounded since the start of the war.

¹⁴ The World Bank estimates Ukraine's GDP will decline by 45% in 2022.

It's challenging to contemplate innovation and competitiveness when there is a struggle to address the population's basic needs. However, some innovations may be rapidly realized if they are essential to improve security or civilian daily needs,¹⁵ for example. Therefore, the innovation lifecycle may progress more swiftly to address the more basic needs during the armed conflict, while innovations that solve top-tier needs may take longer.

Developing a genuine innovation culture takes time and effort. The current crisis might provide Ukraine with an opportunity to accelerate this process due to the sense of urgency and unity that the war has unfolded. Among the war recovery plan, it is of the utmost importance to include the development of an innovation ecosystem that includes:

- Effective investment in research and development and higher education based on a clear and concise vision for innovation.
- Creation of a favorable business environment and promotion of entrepreneurship where people feel comfortable taking risks and experimenting but also learning from their mistakes and getting the support to succeed.
- Encouragement of collaboration and open communication between different sectors where new ideas and solutions can more easily be shared.

¹⁵ For example, the armed conflict has used novel drone and counter-drone systems, on the military side. Among civilian innovations, Ukraine has implemented Starlink, a satellite internet service, and Powerwall, a battery storage system for homes and businesses during blackouts and emergencies.

About the Driving Innovation in Times of Crisis Initiative

The DITC is a multidisciplinary, multi-stakeholder, global initiative to advance the understanding of crisis and harness its potential to generate innovation and promote prosperity. The project started in 2022 with funding and support from our member Japan Science and Technology Agency (JST).

Since then, we have engaged in relevant discussions, unveiling historical moments when innovation flourished in the face of adversity to gather lessons and review solutions. [We invite you to check our report documenting all discussions held in 2022.](#)

In 2023, we onboarded two researchers working in organizations within our network: John Katsos, Ph.D. candidate at Queens University Belfast, and Ailun Gu, a postdoctoral research fellow at the University of Auckland.

They were responsible for collecting, comparing, and synthesizing existing crisis definitions, performing a literature review of crisis typologies and epistemologies, and mapping out relevant examples of crises.

They based their work on extensive academic research and a series of interviews with our members and fellows, which resulted in the publication of a white paper on crisis definitions and frameworks and three case studies, uncovering the 9/11 terrorist attacks, the COVID-19 pandemic, and the ongoing armed conflict in Ukraine. The latter was written by Denys Ilnytskyi, an academic from Kyiv National Economic University, which will be published shortly.

We thank JST for their continuous support, and we look forward to continuing our work to help individuals, businesses, and organizations develop new structures and capabilities to drive prosperity and innovation in times of crisis.

We firmly believe that while a crisis can threaten competitiveness, it also poses numerous opportunities. We want to provide a framework for stakeholders to navigate turbulence, limiting competitiveness losses while enhancing their potential to develop creative solutions and prosper.

For more information, visit our webpage:

<https://www.thegfcc.org/driving-innovation-in-times-of-crisis>

If you want to join us for the journey, please contact:

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