Unstable External Environment as a Challenge for Business Management in Ukraine

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ABSTRACT

Objectives

This research analyzes the transformation of management systems within large-scale Ukrainian businesses facing extreme environmental instability due to military aggression. It focuses on the critical need for adaptive strategies for industrial giants dealing with physical asset destruction and the total blockade of traditional export routes. The main objective is to evaluate destructive factors and provide methodological recommendations for anti-crisis strategies that ensure resilience and modernization in the metallurgical sector during the war and post-war periods.

Methods. The methodology involves a comparative analysis of production and financial indicators for major metallurgical groups, including Metinvest, ArcelorMittal Kryvyi Rih, Interpipe, and Zaporizhstal, from 2021 to 2025. The research integrates traditional Balanced Scorecard (BSC) and Key Performance Indicators (KPI) with modern agile methodologies like Objectives and Key Results (OKR), which are specifically suited for conditions of high uncertainty.

Results. The results systematize macroeconomic shocks and assess a 38% decline in national steelmaking potential, while identifying initial recovery signs in 2024. The study substantiates the importance of dynamic capabilities for rapid business model reconfiguration in response to energy crises. Furthermore, it highlights the implementation of Industry 4.0 digital technologies as a vital tool for improving production efficiency and operational stability.

Conclusions. The study confirms that the metallurgical sector remains the cornerstone of the Ukrainian economy despite catastrophic losses. Future competitiveness depends on market diversification, decarbonization-based modernization, and human capital development to comply with the European Carbon Border Adjustment Mechanism (CBAM). Strategic recommendations are provided for business leaders and policymakers to facilitate sustainable post-war recovery.

Keywords: anti-crisis management, business resilience, metallurgical industry, war economy, scenario planning.

PROBLEM STATEMENT AND ITS RELEVANCE

At the beginning of the 2020s, Ukrainian enterprises operated amidst escalating geopolitical tensions and uneven economic development. Industry contributed significantly to the economy: the metallurgical sector provided about 10% of GDP by 2021, while chemical and machine-building sectors contributed another 8% combined [13]. The Russian armed aggression, which escalated into a full-scale invasion in February 2022, constituted an unprecedented shock for businesses.

The largest sectors were affected immediately: metallurgy, machine building, energy, and the agro-industrial complex. Destroyed infrastructure, the blockade of seaports, damage to energy facilities, and the forced evacuation of workers from dangerous regions led to a sudden drop in production and exports.

The unstable external environment also included financial shocks – hryvnia devaluation, double-digit inflation, high interest rates, a shortage of working capital, and restrictions on foreign exchange operations. Government decisions necessitated by martial law changed rapidly, increasing regulatory uncertainty. Simultaneously, global trends – energy transition, digitalization, restructuring of supply chains, and climate risks – created additional challenges and opportunities.

Under such conditions, large enterprises, especially metallurgical plants, faced the need to urgently revise their strategies and implement anti-crisis measures.

The metallurgical industry has traditionally been a pillar of the Ukrainian economy: it accounted for about 7% of GDP and over 15% of exports in 2024, providing foreign exchange earnings and jobs for hundreds of thousands of people [1].

However, as a result of the war, it lost a significant portion of its capacity: the number of large metallurgical plants decreased from 12 in 2013 to 6 in 2024, total design capacity dropped from 42 million tons to 16.5 million tons, and steel output decreased from 32.7 million tons in 2013 to 7.6 million tons in 2024, nearly 4.3 times less [1]. According to Low Carbon Ukraine, before the war, Ukraine was among the top 14 steel producers in the world and had nominal capacities of about 28.5 million tons, but the 2022 Russian invasion destroyed 38% of these capacities, including 6.6 million tons at "Azovstal" and 4.3 million tons at the Illich Iron and Steel Works [13]. Capacity utilization fell from 75% to 22%, and by 2024 it gradually recovered to 42%, though this remains significantly below pre-war levels [13]. Initial data for the first half of 2025 indicate that pig iron and rolled metal production is slowly recovering, while steel smelting is slightly decreasing, reflecting mixed trends and the need for more precise analysis [2].

PURPOSE OF THE ARTICLE AND METHODOLOGY

The objective of this section is a comprehensive analysis of the unstable external environment as a challenge for business management and the development of recommendations for an anti-crisis strategy. The research is based on official data from the "Ukrmetallurgprom" Association of Enterprises, the professional association GMK Center, analytical reports from Metinvest and Interpipe companies, reports from the National Bank of Ukraine, as well as international studies by Low Carbon Ukraine and the Oxford Institute for Energy Studies. A comparative analysis of indicators for 2021–2025 was used, allowing for the assessment of the depth of crisis phenomena, identification of recovery trends, and formulation of strategic priorities for large enterprises in the metallurgical sector.

Macroeconomic and Geopolitical Factors of Instability

War and Security Risks

The most significant factor of instability is the ongoing Russo-Ukrainian war. Military actions led to the destruction of industrial facilities in Donbas and eastern Ukraine, where most metallurgical capacities are concentrated. Enterprises such as Azovstal and the Mariupol Illich Iron and Steel Works were destroyed or seized, depriving the country of 38% of its steelmaking capacity.

Other plants were forced to stop production due to the threat of shelling and raw material shortages. Logistics corridors through the Black Sea were blocked several times; ore supplies from the Kryvyi Rih basin for export were carried out primarily by rail and through Polish and Romanian ports, which increased time and costs.

Periodic power outages caused by strikes on energy infrastructure reduced the capabilities of electric arc furnaces and forced enterprises to operate in shift modes. In response, companies developed backup plans: moving part of production to relatively safe western regions, building warehouses abroad, diversifying supply routes, and cooperating with state authorities to protect critical infrastructure and support supply continuity.

Economic Shocks and Financial Instability

In parallel with military risks, enterprises experienced strong macroeconomic fluctuations. In 2022, Ukraine's GDP contracted by 28.8%, but in 2023 it grew by 5.5%, and in 2024 the growth rate slowed to 2.9%.

Each quarter of 2024 showed lower dynamics than in 2023, and in the fourth quarter, there was even a slight decline in GDP, indicating the prolonged nature of the crisis. The inflation rate reached 26% in 2022, gradually slowing down to 12% in 2024; at the same time, the real purchasing power of the population remained low, limiting domestic demand for metal products. The hryvnia exchange rate devalued from 27 UAH/USD in 2021 to 39 UAH/USD in 2024, complicating cost planning and debt servicing in foreign currency.

The government was forced to increase taxes and fees to finance defense, which increased the fiscal burden on business; however, in 2024, a series of incentives for investment in critical industries were introduced, including tax holidays and interest rate compensation for production restoration.

Interest rates on loans remained at 20–25%, making borrowing for equipment modernization virtually inaccessible. In response, companies strengthened control over cash flows, reoriented operating budgets, attracted financial support from international partners, and used risk management mechanisms, such as hedging currency risks.

Furthermore, pressure on energy tariffs intensified: in 2024, electricity prices for industry more than doubled due to a power generation deficit and electricity imports from the EU; this increased the cost of metal products and reduced margins.

Human Capital, Demographic Changes, and the Labor Market

War events have led to mass displacement of the population: over 4.6 million people have become internally displaced persons, and 6.9 million are refugees abroad, which has reduced the potential labor force in industry [13]. In regions where metallurgical plants are located (Dnipropetrovsk, Zaporizhzhia, Donetsk regions), a large portion of skilled workers has been mobilized or evacuated.

Companies have faced staff shortages and were forced to increase wages to retain personnel. According to an economic report by GMK Center, the average salary in metallurgy was 30% higher than the Ukrainian average in 2024, while employment decreased by 8% compared to the pre-war period [1]. An additional problem is the psychological fatigue of employees, the need to ensure workplace safety, and the maintenance of motivation.

Enterprises are implementing social support programs, family relocation, medical insurance, and organizing training sessions on safety techniques and first aid.

An important aspect is the attraction of new personnel and retraining: companies cooperate with universities and vocational schools, develop their own training centers, and motivate young people to remain in Ukraine.

Regulatory Changes and International Relations

The regulatory field is undergoing changes due to martial law, Ukraine's integration into the EU, and the requirements of international financial organizations.

The governments of partner countries introduced sanctions on Russian steel, opening new opportunities for Ukrainian exporters. However, at the same time, the EU is implementing the Carbon Border Adjustment Mechanism (CBAM), which from 2026 involves certification and payment of duties for CO2 emissions. According to an assessment by Low Carbon Ukraine, CBAM could cause a loss of up to 248 million euros in EBITDA annually for Ukrainian producers if they do not invest in low-carbon technologies [13]. For Ukrainian metallurgists, this means a need to modernize equipment, transition to electric steelmaking and hydrogen technologies, and more actively implement clean energy.

The Government of Ukraine in 2023–2024 proposed an industrial policy that includes tax privileges for investments, reimbursement of part of the interest rate, and access to recovery funds, but bureaucratic obstacles and corruption risks slow down the implementation of these initiatives. Furthermore, the country must take into account the requirements of the free trade agreement with the EU (ACAA agreement), standards of competition policy and state aid, and adapt national legislation to European directives.

Operating Results of Major Metallurgical Enterprises

Comparison of Pre-war Capacities with the 2021–2024 Period

In the 2010s, the Ukrainian metallurgical industry was among the top ten global steel producers. In 2013, the country produced 32.7 million tons of steel, while its design capacity was estimated at 42 million tons. However, by 2021, due to the annexation of Crimea, hostilities in Donbas, and a lack of investment, output fell to 21.4 million tons, and the number of active plants was reduced to eight.

The full-scale invasion in 2022 led to the loss of the Ilyich Iron and Steel Works and "Azovstal" in Mariupol, reducing the number of producers to six and shrinking capacity to 16.5 million tons.

Table 1 shows the output of main products for 2021–2024, illustrating the production collapse and gradual recovery.

Table 1: Production of Main Products (2021–2024)

Product	2021 (M t)	2022 (M t)	2023 (M t)	2024 (M t)	Δ 2024/2023 (%)
Iron ore	75.1	37.2	48.3	75.0	+55.2
Pig iron	21.1	6.4	6.0	7.09	+18.1
Steel	21.4	6.3	6.23	7.58	+21.6
Ferroalloys	0.58	0.21	0.35	0.48	+37.1
Long products	5.77	2.46	2.34	2.96	+26.5
Flat products	8.92	2.21	2.20	2.38	+8.2
Pipes	0.84	0.32	0.43	0.57	+32.6
Scrap metal collection	2.97	1.08	0.97	1.54	+58.8

Source: GMK Center analytical report "Economic effect of Ukrainian iron and steel industry – 2024". According to the table, 2024 was a year of partial recovery: pig iron production increased by 18.1% and steel by 21.6% compared to 2023, though it still represented only a third of 2021 levels. Iron ore production returned nearly to pre-war levels (75 million tons), as mining and processing plants are located far from the front line and adapted more quickly. Ferroalloys, long products, and flat products showed high growth rates, explained by the recovery of domestic demand and the operation of the export "grain corridor" for steel via the Black Sea.

Financial Results and Corporate Investments

The largest Ukrainian metallurgical groups—Metinvest, ArcelorMittal Kryvyi Rih, Interpipe, and Zaporizhstal—are the key drivers of the industry. According to Metinvest's 2023 consolidated report, the company's revenue was $7.397 billion, an 11% decrease from 2022, with a net profit of $338 million. In 2024, Metinvest increased its revenue to $8.050 billion, up 9% from 2023; the metallurgical segment's share grew to 60%, while the mining segment's share decreased to 40%.

Domestic sales in 2024 decreased by 2%, while export shipments to the EU, Turkey, and North Africa increased by 15%. The relative weight of iron ore, pig iron, and steel product processing increased, while pig iron exports dropped by 32% due to high logistics costs.

In 2023, ArcelorMittal Kryvyi Rih produced 1 million tons of steel and 1.5 million tons of pig iron, representing decreases of 18.5% and 12% respectively compared to 2022; capacity utilization was only 25–30%. However, in 2024, the company implemented a blast furnace modernization program and plans to transition to the electric steelmaking method to reduce dependence on natural gas and coal. The Kametstal plant (Metinvest Group) produced 1.3 million tons of pig iron and 1.5 million tons of steel in 2023, demonstrating steady growth through production line optimization and access to alternative logistics routes.

Interpipe plays a significant role, specializing in the production of pipes and railway wheels. According to the annual report and a publication by SteelOrbis, in 2024, Interpipe earned a net profit of $280.48 million, compared to $252.89 million in 2023; total revenue increased by 6.2% to $1.05 billion, while the production of steel and pipes grew by 22.6% and 28.3% respectively, reaching 834,000 tons of steel and 507,000 tons of pipes. The sales volume of railway wheels in 2024 amounted to 112,000 tons, with a total sales volume of 657,000 tons (+27.5% y/y). The company forecasts the maintenance of a duty-free and quota-free export regime to the EU in 2025, which will facilitate further growth.Another leading player is Zaporizhstal (Metinvest Group).In 2024, the plant invested 938 million UAH in maintaining production capacities, whereas investments were 500 million UAH in 2022 and 750 million UAH in 2023; the budget is planned to increase to 1.1 billion UAH in 2025.Specifically, blast furnaces No. 2–4 were repaired, rolling mills were modernized, and projects for digitalization and labor safety enhancement were implemented.In 2024, Zaporizhstal increased the production of commercial rolled products by 18.3% (to 2.43 million tons), pig iron by 14.3% (to 3.11 million tons), and steel by 17.2% (to 2.89 million tons) compared to 2023.Management notes that the main growth factors were the increased productivity of blast furnaces, higher demand for merchant pig iron, and the partial restoration of the maritime route.Investment activity remains substantial. According to a report by GMK Center, in 2024, capital investments in the metallurgical sector reached $650 million, accounting for 18.3% of all industrial investments. Funds were directed toward equipment repairs, restoration of damaged workshops, development of new steel grades, environmental projects, and the implementation of the first stage of "green" metallurgy. Priority areas include the construction of electric steelmaking complexes, reconstruction of rolling mills, and the implementation of clean energy technologies.

Current Trends of 2025

Operational data for January–June 2025 indicate mixed dynamics. Pig iron production increased by 5.8% compared to the same period in 2024, reaching 3.67 million tons, while steel production decreased by 4.9% to 3.68 million tons, and rolled products output fell by 2.2% to 3.07 million tons. The growth in pig iron is attributed to the stable operation of blast furnaces, while the drop in steel smelting is due to the high cost of electricity and limited access to graphite electrodes for electric arc furnaces.At the same time, the consumption of rolled steel on the domestic market increased by 13% to 1.94 million tons, thanks to the recovery of the construction sector and the implementation of state infrastructure programs.Steel imports rose by 29.6% to 716,700 tons, while exports decreased by 6.5% to 1.85 million tons.The export structure shows that 83% of shipments were to EU countries (Poland, Italy, Germany), with the remainder going to Turkey, Malaysia, and North Africa.Energy supply restrictions and increased electricity tariffs forced enterprises to implement alternating operations for blast furnaces and invest in backup power sources. Meanwhile, projects for building "green" metallurgy continue: investments in renewable energy and hydrogen technologies could provide Ukraine with an additional gross value added (GVA) increase of $164 billion and a reduction in CO_2 emissions, which is a prerequisite for access to the European market under CBAM.Thus, despite short-term difficulties, the industry demonstrates potential for transformation and growth.

Contribution of the Industry to the Economy and Social Sphere

Beyond production figures, the metallurgical sector's contribution to the economy and social sphere is significant:

GDP Contribution: In 2024, the sector accounted for 7.2% of GDP, an increase from 5.7% in 2023.

Export Revenue: The share of metallurgical products in the structure of export earnings exceeded 15.4%, making it one of the largest sources of foreign currency inflows.

Tax Payments: The five largest companies transferred approximately $0.9 billion in tax payments to the budget. This represents 1.7% of all tax revenues.

Wages: The average salary in the industry was 30% higher than the national average.

Employment: Despite an 8% drop in employment, the industry remains a major employer, retaining tens of thousands of workers with specialized skills.

The high wage levels and substantial tax contributions make metallurgy a key player in the social stability of regions where plants are located; therefore, the resilience of these enterprises is of strategic importance to the country.

Environmental Challenges and the Path to "Green" Steel

The Ukrainian steel industry is one of the most carbon-intensive in the world: the production of one ton of steel accounts for approximately 2.3 tons of CO

Historically, the industry has relied on blast furnace (BF–BOF) and open-hearth furnace (OHF) technologies, which consume significant volumes of coke, natural gas, and electricity. Before the war, electric arc furnace (EAF) capacity—which uses scrap metal—stood at only 2.3 million tons, compared to 22.1 million tons of BF–BOF capacity, confirming a heavy reliance on carbon-intensive fuels.

The transition to low-carbon steel is both an environmental and economic necessity, as carbon taxes and the CBAM will gradually reduce the competitiveness of high-emission products. Between 2023 and 2025, Ukrainian companies began developing projects for electric arc furnaces, direct reduced iron (DRI) plants, and hydrogen-based furnaces.

Metinvest: In collaboration with the Italian company Danieli and the German bank KfW, Metinvest plans to build a demonstration complex in Yavoriv to produce steel using hydrogen and renewable electricity.

Interpipe and Zaporizhstal: Both companies have expressed readiness to join pilot "green" steel projects, developing scrap collection and recycling programs to reduce the need for primary ore.

Investment Needs: The development of green metallurgy requires massive investment. Analysts estimate that modernizing facilities for hydrogen use alone requires $62 billion. However, this could provide the economy with an additional $164 billion in gross value added (GVA).

Theoretical and Methodological Approaches to Crisis Management

Balanced Scorecard and KPI as Strategic Control Tools

Among the classic tools of strategic management, the Balanced Scorecard (BSC) occupies a special place. This system, proposed by R. Kaplan and D. Norton, involves mapping strategy as a set of objectives distributed across four perspectives: finance, customers, internal processes, and learning and growth. For each perspective, performance indicators (KPIs), target values, and initiatives are defined, allowing for a balance between short-term and long-term priorities.

For metallurgical enterprises, these perspectives might include:

Financial: EBITDA margin, return on invested capital, and export volume.

Customer: Satisfaction of industrial consumers and market share.

Internal Processes: Productivity of blast furnace and rolling units, metal losses, and downtime percentage.

Learning and Growth: Investment in personnel, percentage of advanced training programs, and implementation of digital systems.

Regular tracking of KPIs helps managers understand whether results align with strategic goals and allows for timely adjustments to development directions. In domestic practice, the BSC is used by companies such as Metinvest, ArcelorMittal Kryvyi Rih, and Interpipe to monitor production efficiency, environmental responsibility, and personnel status. An example of this is the developed scorecards where each indicator corresponds to a specific project (e.g., reducing energy consumption, decreasing downtime, or increasing customer satisfaction).

OKR, Scenario Analysis, and Dynamic Capabilities

The conditions of extreme uncertainty inherent in Ukraine during the war require flexible management methods. The Objectives and Key Results (OKR) system, popularized by technology companies (Google, Intel) and startups, suggests setting ambitious goals for short periods (quarterly or half-yearly) with quantitative key results to achieve them.

The transparency of OKRs within an enterprise promotes clarity and team interaction; regular reviews allow for rapid responses to external changes. In metallurgy, the combination of long-term KPIs and short-term OKRs might look like a strategic goal of "achieving a 50% share of low-carbon products by 2030" paired with quarterly OKRs regarding the launch of a pilot hydrogen furnace or securing $50 million in investment.

Scenario planning is another crucial tool. Between 2022 and 2024, companies considered scenarios such as:

"Blockade": Total closure of ports.

"Partial Recovery": Operation of the grain/steel corridor.

"Deep Modernization": Construction of "green" production units.

For each scenario, necessary resources, risks, and expected results were determined. Furthermore, modern strategic management research emphasizes the concept of dynamic capabilities, proposed by D. Teece. This is the ability of an enterprise to sense changes (sensing), seize opportunities (seizing), and transform the business model (reconfiguring) in response to external challenges.

For metallurgical companies, dynamic capabilities are manifested in:

Rapid market switching: Moving between the EU, Turkey, and the Middle East.

Product portfolio adaptation: Adjusting to changing demand.

Technology integration: Implementing new technologies such as Direct Reduced Iron (DRI) and Electric Arc Furnaces (EAF).

Risk Management and Ensuring Supply Chain Sustainability

In crisis conditions, systematic risk management is of particular importance. The international standard ISO 31000 and the COSO ERM methodology propose a sequence of actions: risk identification (operational, financial, strategic), probability and consequence analysis, determination of risk limits, selection of response methods (avoidance, reduction, transfer, or acceptance), and monitoring.

Metallurgical enterprises implement early warning systems: they monitor raw material prices, energy tariffs, political decisions, and logistics corridors to quickly adjust contract terms and draw up budgets considering various scenarios. Supply chain resilience is ensured through supplier diversification, creating raw material stockpiles, concluding long-term contracts for railway and port services, and using multimodal transport schemes (rail – river – sea).

Information technologies play a significant role: tracking systems, blockchain platforms for documents, and electronic metal exchanges increase transparency and reduce the risk of fraud. Cooperation between producers, logistics companies, the state, and financial institutions allows for the creation of adaptive ecosystems capable of supporting exports even during blockade periods.

The Role of Digitalization and Industry 4.0

In modern industry, digital transformation becomes a decisive factor in competitiveness. According to OECD and the Government of Ukraine, small and medium-sized enterprises lag significantly behind companies in OECD countries in terms of digital technology implementation, while large industrial groups (Metinvest, Interpipe) actively use ERP, CRM, predictive maintenance systems, the Internet of Things, and Big Data analytics [8].

The implementation of Industry 4.0 in metallurgy includes:

Automated furnaces and rolling mills

Sensors for monitoring temperature, pressure, and gas composition

Robotic cranes and warehouses

Digital twins and process modeling

This allows for increased productivity, reduced energy consumption, faster defect detection, and repair planning. During wartime, digital technologies also provide the possibility of remote control, minimizing human presence in dangerous areas. However, full digitalization requires investments in IT infrastructure, cybersecurity, and the development of personnel competencies.

Regional differences in digitalization remain significant: according to the digital transformation index, the highest indicators are in Dnipropetrovsk (0.908) and Lviv (0.891) regions, while the lowest are in Sumy (0.178) and Zaporizhzhia (0.289). Companies must take these disproportions into account when planning projects and direct resources to personnel training in lagging regions.

Despite the obvious potential, digitalization in Ukraine is occurring unevenly. According to the 2023 Regional Digital Transformation Index compiled by the Ministry of Digital Transformation, the leaders in digital readiness are Dnipropetrovsk, Lviv, and Poltava regions (coefficients 0.908; 0.891; 0.833 respectively), while Kherson, Zaporizhzhia, and Sumy lag behind (0.316; 0.289; 0.178) [17]. The national average is 0.632, and Kyiv has an index of 0.684 [17]. The reasons for the lag include a lack of human capital, weak development of internet infrastructure, and limited penetration of electronic services in remote communities [17]. Therefore, corporate strategies must include digital competency enhancement programs and investments in regional initiatives to help close the digital divide.

A vital component of digital transformation is predictive maintenance, which uses Big Data analytics and machine learning to predict equipment failures. At metallurgical plants, sensors are installed to monitor vibrations, temperature, and wear, allowing for planned repairs and reduced downtime. Digital twins—virtual models of blast furnaces and rolling lines—make it possible to simulate various production scenarios, optimize energy consumption, and improve product quality.

Artificial intelligence systems help forecast demand, optimize cargo routes, and manage inventories, while blockchain technologies are used to track the origin of metal products and reduce the risk of counterfeiting. Enterprises are implementing corporate cybersecurity centers, strengthening protection against cyberattacks, which have become more common during the war. Notably, Ukraine is developing the state platform Diia.Business and the Diia.City project, which provide startups and IT companies with a special tax regime and access to digital services; metallurgical enterprises can use these tools to launch innovative projects and collaborate with the startup ecosystem.

Another relevant topic is e-commerce and remote customer service. According to OECD data, online sales volume is growing even under war conditions: in 2023, almost a quarter of Ukrainian firms conducted e-commerce operations, and the number of digital service users doubled compared to 2020 [17]. For metallurgical companies, this means the need to create platforms for electronic product booking, real-time order tracking systems, and online customer support. The combination of digital transformation and physical modernization can significantly increase the resilience of companies to shocks and ensure their leading positions in the European market.

International Experience and Best Practices

The analysis of international experience demonstrates that crisis situations in metallurgy are overcome through a combination of state support, technological modernization, and strategic cooperation between companies.

Turkey: During the COVID-19 pandemic, the government provided preferential loans and subsidies to modernize electric arc furnaces; this allowed the country to increase steel production to 33.7 million tons in 2024, ranking seventh globally.

Poland: Integrated into ArcelorMittal's supply chains, Poland receives EU funding for decarbonization projects and the development of hydrogen infrastructure; with state support, Polish plants are reducing CO_2 emissions and mastering steel production from renewable sources.

Sweden: A pioneer in "green" steel production, H2 Green Steel is implementing a project to create a complete hydrogen chain, aiming to produce 5 million tons of steel per year using renewable energy; this project targets a 95% reduction in emissions compared to traditional technologies.

Germany and Italy: These countries actively implement subsidy programs for electric furnaces and blast furnace gas utilization; the "Transformation Stahl" programs in Germany provide compensation for up to 80% of the additional costs of green hydrogen.

Japan: The government and business jointly finance innovations; the JISF consortium implements programs for carbon capture and storage (CCS), using ammonia as a fuel additive, and production robotics.

For Ukraine, it is vital to adopt these practices: develop a system of state grants and tax incentives for "green" metallurgy, attract strategic partners (Danieli, SMS Group, Primetals), and create a domestic market for low-carbon metal products.

Financial and Investment Strategy

Restoring and modernizing Ukrainian metallurgy requires financial resources that exceed the capabilities of individual companies. Key instruments include project financing and public-private partnerships.

International Financial Organizations: Organizations such as the EBRD, IFC, and EIB are already providing loans and guarantees for infrastructure projects, including port and railway modernization.

ESG Standards: Companies must prepare investment projects in accordance with Environmental, Social, and Governance (ESG) standards to increase attractiveness to institutional investors.

Risk Management: Utilizing war risk insurance mechanisms (e.g., through the IFC and MIGA) is essential to reduce premiums and attract private capital.

Financial Instruments: Green bonds and transition bonds are additional sources that allow for the financing of environmental projects at preferential rates.

National Fund: At the state level, it is advisable to create a National Fund for Metallurgy Transformation, funded by the state budget, customs revenues, and international aid.

Currency risk management is also critical; companies should utilize forward contracts, natural hedges (matching export and import currencies), and maintain reserves in the currencies used for major equipment purchases.

Human Capital Management and Corporate Social Responsibility

Human capital is the primary asset of enterprises during times of crisis. The war has caused a labor outflow due to mobilization and migration, requiring focused efforts to retain and attract personnel.

Retraining Programs: Development of "green" and digital competencies (managing hydrogen furnaces, working with digital twins, cybersecurity) and mastering new professions such as robotics operators and data analysts.

Flexible Employment: Implementing remote work, on-demand shifts, and part-time schedules to help employees balance work with mobilization obligations and family needs.

Psychological Support: Establishing psychological assistance programs, stress management training, and burnout prevention.

Companies must also implement social projects in their host communities: restoring destroyed infrastructure, supporting educational and medical centers, and providing housing for employees and their families. Corporate Social Responsibility (CSR) serves as a factor for reputational attractiveness, influencing the ability to attract investment and cooperate with international partners.

Strategic Recommendations

Based on the analysis of external factors and the internal resources of enterprises, the following proposals for developing a crisis management strategy are formulated:

1. Systemic assessment of the environment

Establish analytical centers within companies responsible for conducting PESTEL, SWOT, and VRIO analyses to evaluate the impact of macroeconomic, socio-political, technological, environmental, and legal changes.

Monitor global trends (CBAM, energy transition, digitalization, supply chain reorientation) to respond timely to opportunities and threats.

Utilize business intelligence systems to integrate internal indicators with external data.

2. Investment planning for reconstruction and modernization

Formulate long-term capital construction programs considering CBAM requirements and the transition to "green" steel.

Attract project financing from international financial institutions, EU funds, and recovery programs; utilize risk guarantee mechanisms through export-credit agencies.

Conduct energy audits of enterprises, identify priority areas for modernization, and build a phased decarbonization plan.

3. Product portfolio diversification and entry into new markets

Develop the production of semi-finished products, wire rod, pipes, and special steels with high added value, adapting products to the requirements of European and Asian consumers.

Seek counterparties in the Middle East, Africa, South America, and Southeast Asia to compensate for turbulence in EU markets.

Develop proprietary trading companies and logistics hubs abroad.

4. Financial stability and risk management

Ensure transparency in financial reporting, optimize the cost structure, reduce debt burdens, and create a liquidity cushion.

Implement a currency risk hedging policy, enter into long-term contracts for the supply of raw materials and energy resources, and establish insurance reserves.

Account for possible fluctuations in steel product prices and demand changes in different regions when budgeting.

5. Human capital development

Invest in professional education and collaborate with technical universities to train personnel for "green" metallurgy; ensure decent working conditions and social guarantees.

Implement experience exchange programs with steelmaking enterprises in the EU and Turkey; incentivize the return of labor migrants through competitive working conditions.

Develop internal management schools focusing on crisis management, digital competencies, and ESG principles.

6. Logistic and energy independence

Diversify logistics routes using rail, river, and sea corridors; invest in expanding terminals on the Danube and building proprietary transshipment complexes in Poland or Romania.

Develop programs for installing autonomous power plants (biomass, solar, wind), sign long-term contracts with green energy producers, and build electrolyzers for hydrogen production.

Implement energy management systems that optimize consumption and reduce losses.

7. Environmental and social responsibility

Adhere to ESG requirements: reduce greenhouse gas emissions, control waste, and ensure the safety and health of workers.

Report openly on environmental programs, support community sustainable development initiatives, and contribute to infrastructure restoration in frontline regions.

Collaborate with local communities and veteran organizations to create jobs and implement social projects.

8. Digital transformation and innovation

Invest in the implementation of MES, ERP, CRM, IIoT, big data analytics, and artificial intelligence to optimize production processes, predictive maintenance, and planning.

Develop and implement digital platforms for interaction with suppliers and customers, ensuring transparency and speed of operations.

Foster a culture of innovation: encourage teams to experiment, collaborate with startups and research centers, and implement internal entrepreneurship programs.

International and Industry Context

It is crucial to view Ukrainian metallurgy within a broader international context. Before the war, Ukraine was the 14th largest steel producer in the world and competed with countries like Turkey, Italy, and Germany [13]. The shutdown of Azovstal and the Ilyich Iron and Steel Works deprived Ukraine of 38% of its production capacity, while competitors continued to increase output to fill the niche.

Turkey: In 2024, produced 33.7 million tons of steel, increasing investment in electric arc furnaces and domestic ore enterprises.

Poland: ArcelorMittal's Polish plants are investing in decarbonization and receiving state support.

The experience of these countries shows that success depends on active state policy aimed at supporting exports, modernization, and environmental improvement. Ukraine has the potential to find its place in the European "green steel" system due to high renewable energy potential, high-quality ore in the Kryvyi Rih basin, and strategic proximity to European markets.

Key Global Trends Affecting Ukrainian Enterprises:

Market Stagnation: According to the World Steel Association, global steel production fell by 2.5% in 2024, and consumption decreased by 3% due to slumps in construction and machinery.

CBAM (Carbon Border Adjustment Mechanism): From 2026, the EU will levy duties on high-carbon steel imports. Analysts estimate this could lead to annual EBITDA losses for Ukrainian companies ranging from 150 to 250 million euros [13].

Logistics Constraints: The Black Sea region remains a risk zone, leading to increased use of routes via the Danube, land corridors through Poland and Romania, and transshipments in Turkey, which raises final prices.

Certification: There is increased focus on products such as EU Green Steel and ResponsibleSteel. Joining these initiatives is vital for maintaining access to premium markets.

CONCLUSION

The unstable external environment—driven by war, geopolitical tensions, economic shocks, and rapid technological change—has presented an unprecedented challenge for the management of large enterprises in Ukraine.

The metallurgical industry, which serves as the foundation of the country's industrial potential, has suffered significant losses: capacities have been halved, and steel production has decreased to one-third of pre-war levels. While 2024 saw a partial recovery in production and export growth thanks to the opening of the maritime corridor, the dynamics in the first half of 2025 were mixed—pig iron production increased, while steel and rolled products slightly declined.

The financial results of leading companies have improved, yet they remain highly dependent on global market conditions, logistics costs, and energy prices. Despite these profound losses, the industry remains vital to the national economy, accounting for a significant share of GDP, exports, tax revenues, and employment.

Strategic Path Forward

For long-term success, it is necessary to:

Combine quantitative assessment methods such as KPIs, Balanced Scorecards (BSC), and OKRs with flexible strategic planning.

Invest in modernization and decarbonization to meet international standards.

Diversify products and markets to mitigate regional volatility.

Build resilient supply chains and develop human capital alongside digital competencies.

The partnership between business, the state, and international financial institutions will be a crucial component in providing the resources necessary for recovery and the transformation of Ukrainian metallurgy into a competitive segment of the European green economy.

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