

Construction project risk management under contingent circumstances: Case of Ukraine-Russia War

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<https://doi.org/10.31462/jcemi.2026.617>

Received 16 October 2025; Revised 25 May 2026; Accepted 5 June 2026; Available online 25 June 2026

Keywords

Risk management
Construction in war zone
Conflict
Sanctions
Russia
War-time

Abstract

The construction industry faces growing exposure to uncertainty and volatility, particularly under conditions of armed conflict and geopolitical disruption. While existing research largely concentrates on post-conflict reconstruction, limited attention has been devoted to projects that continue during active warfare, where risk factors remain fluid and continuously evolving. This study examines the distinct risks associated with construction projects executed during wartime, identifying their typologies across recent conflict contexts and developing a structured classification framework to support decision-making under extreme uncertainty. Drawing upon an extensive literature mapping and an in-depth case analysis of the Moscow Headquarters Project—undertaken amid the Russia–Ukraine conflict—the research systematizes wartime risks into six domains: political and security, supply chain, financial and contractual, operational and workforce, technological, and environmental. The framework highlights how contemporary conflicts increasingly extend beyond kinetic warfare to include prolonged economic sanctions, regulatory isolation, and technological embargoes, all of which reshape the landscape of construction risk. By bridging theoretical insights and empirical observation, this study advances the understanding of construction project resilience under contingent circumstances, offering a conceptual basis for adaptive management strategies and risk-informed decision-making in conflict-affected environments.

1. Introduction

The construction industry is characterised by uncertainty, complexity, and interdependence. Conventional risk management practices address challenges such as cost overruns, schedule delays, resource shortages, and regulatory shifts. However, the emergence of contingent circumstances—such as armed conflict, political instability, and war—introduces a unique spectrum of risks that transcend traditional frameworks. In contrast to market fluctuations or technical uncertainties, wars and conflicts have the capacity to disrupt the very foundations upon which projects are conceptualised and executed. This disruption encompasses workforce availability, supply chain continuity, financing structures, and the safety of stakeholders. While conventional studies in construction project risk management have primarily focused on cost, schedule, and resource-related risks under relatively stable or peacetime conditions [1, 2], the literature also recognizes additional categories such as contractual, regulatory, environmental, and stakeholder-

related risks. However, wartime circumstances introduce a distinct and intensified risk landscape, where armed conflict disrupts the very foundations of project delivery by affecting workforce mobility, supply chain continuity, financial flows, and the physical safety of stakeholders [3]. Unlike post-conflict reconstruction, projects that commence or continue during active war face ongoing volatility, where security threats and infrastructure destruction coexist with urgent demands for new facilities.

In regions affected by armed conflict, construction projects occupy a paradoxical position: they are essential for sustaining and restoring critical infrastructure, yet remain highly vulnerable to disruption. The destruction of transport networks, energy facilities, and public buildings underscores both the urgency of construction activity and the fragility of projects operating in volatile environments. While existing literature on construction risk management emphasizes probabilistic assessments, contractual allocation, and insurance-based mitigation, such approaches presuppose

political and social stability. Under wartime conditions, risks escalate unpredictably, requiring a shift from static risk registers to adaptive frameworks that integrate resilience, agility, and scenario-based planning as core principles for project continuity and survival.

The intersection of conflict studies and construction management has received comparatively little attention from researchers, resulting in a dearth of knowledge regarding the potential for redefining risk management methodologies to address the unique challenges posed by contingent war-related risks. The present study contributes to the existing body of knowledge by examining the nature of risks faced by construction projects under war conditions, evaluating existing risk management frameworks, and proposing adaptive strategies to enhance project resilience.

2. Literature Review

2.1. General risk management in construction

Risk management has long been recognized as a key component of construction project success. The industry is inherently exposed to uncertainties ranging from cost escalation, design changes, and supply delays to health and safety concerns [1, 2]. Established frameworks emphasize the identification, allocation, and mitigation of risks across the project lifecycle [4]. Research also highlights the significance of political, financial, and environmental factors in shaping project outcomes. While such studies provide robust foundations for generic risk management, most do not consider the added complexity of wartime or conflict environments, where risks intensify due to instability, infrastructure destruction, and security threats.

2.2. Construction projects under contingent circumstances

Construction project risk management under wartime conditions represents a critical area of study that extends traditional project risk theory into the complex domain of conflict-affected environments. The literature reveals that war conditions fundamentally alter the risk landscape for construction projects, creating unique challenges in both financial management and time scheduling that require specialized theoretical frameworks and practical approaches [5]. The literature review conducted in this section examines the current state of research on construction project risk management under war conditions, with particular focus on financial risks and time extension challenges.

The literature on construction in war-affected contexts has expanded in recent years, particularly in Afghanistan, Iraq, Syria, Yemen, and Ukraine. Several studies highlight that armed conflict introduces not only traditional risks—such as cost overruns and labour shortages—but also unique risks including infrastructure collapse, sanctions, and security-driven site shutdowns. Ullal [6] reports that Afghanistan's construction sector faced severe challenges in maintaining

supply chains and labour availability during wartime. Ivanova [7] similarly examine Ukraine's construction industry under martial law, finding that transportation bottlenecks, disrupted supply chains, and material scarcity were major obstacles. Lyubchenko [8] further emphasize the urgency of emergency restoration work for buildings damaged by bombardments, where hazardous rubble complicates environmental safety.

Beyond supply and operational concerns, contractual and governance issues are also documented. Hansen and Kremers [4, 9] analyze how force majeure clauses, war exclusions in insurance, and the role of military-civilian collaboration influence project execution. In counterinsurgency contexts, military involvement in Afghanistan's reconstruction has been noted to introduce reconstruction planning aligned with security priorities, making it difficult to separate civil engineering management from security-related constraints. Post-war reconstruction research also underscores the trade-off between sustainability and speed. Khaddour [10] demonstrate that sustainability goals in Syria's reconstruction are often compromised due to the urgency of housing delivery. Alashwal [11] identify innovative technologies used under "special conditions," yet note that their application remains constrained by unstable environments. In parallel, U.S. Congressional reports on military construction in Afghanistan and Iraq highlight the scale and cost of wartime infrastructure programs, further illustrating how geopolitical conditions shape project outcomes [12].

To provide a structured synthesis of the literature, this review organizes wartime construction risks around two primary project performance objectives that are most consistently reported and measurable across empirical studies: cost performance (financial risk and cost overruns) and time performance (schedule risk and time extensions). While other dimensions of project success such as quality, scope, safety, and stakeholder outcomes are also critical in conflict-affected environments, the available evidence base most frequently quantifies and discusses wartime impacts through budget escalation and schedule disruption. Accordingly, Sections 2.3 and 2.4 focus on these two dominant objectives, while recognizing that cost and time risks often interact with broader concerns such as safety and operational feasibility.

2.3. Theoretical foundations and conceptual frameworks: Risk theory in conflict contexts-cost overruns

The theoretical foundations for understanding construction risks under war conditions build upon general project risk management theory but emphasize conflict-specific drivers that invalidate normal assumptions about probability distributions, market stability, and institutional continuity [13]. Traditional risk management models assume relatively stable operating environments, but war conditions introduce what researchers term "deep uncertainty" where probability distributions become unreliable and standard risk assessment

methodologies may fail. Hansen [4] provides a comprehensive analysis of contractual theory applications in wartime construction, emphasizing the centrality of force majeure clauses and war-specific contract provisions for allocating conflict-related contingencies. The research demonstrates that standard construction contracts often inadequately address the unique risks posed by active conflict, necessitating specialized contractual frameworks that can accommodate extreme uncertainty and rapid environmental changes.

Recent studies have integrated stakeholder theory and psychometric risk perception models to better understand how construction risks are perceived and managed in conflict zones [14]. These frameworks recognize that risk assessment in war conditions cannot rely solely on quantitative models but must incorporate cultural, social, and psychological factors that influence stakeholder behavior and decision-making under extreme stress.

The literature also emphasizes the importance of tactical project management approaches that shift from strategic, long-horizon planning to adaptive, short-cycle management systems [15]. This theoretical shift reflects the need for construction projects to maintain operational flexibility and safety during rapidly changing wartime conditions.

Financial risks in construction projects under war conditions manifest through multiple interconnected channels that amplify traditional cost management challenges. The empirical literature consistently identifies several key financial risk categories that demonstrate significantly higher probability and impact in conflict environments compared to peacetime construction. Direct security-related costs represent a primary source of financial exposure, encompassing damage repairs, material losses, and protective security measures. Ullal [6] demonstrate through quantitative modeling that security-related delay factors, including local armed interference and evacuation requirements, constitute high-severity contributors to cost escalation in Afghanistan construction projects. Their analysis reveals that security costs can increase project budgets by 15-30% beyond normal contingency allowances.

Currency fluctuation and macroeconomic instability emerge as consistently high-ranking financial risks across multiple conflict-affected regions. Currency fluctuation has consistently been identified as a primary economic risk factor in Lebanese construction projects, while similar patterns have also been documented in Ukrainian construction projects under wartime conditions [16]. The literature indicates that currency devaluation can occur rapidly and unpredictably during conflicts, creating substantial financial exposure for projects with extended durations or significant imported material components.

Funding disruptions represent another critical category of financial risk, manifesting as delayed progress payments, unavailability of funds, and project suspension risks. Choudhry et al. [16] rank unavailability of funds as the

highest-priority financial risk affecting both cost and schedule performance in bridge construction projects in conflict-affected regions. Their empirical analysis demonstrates that funding interruptions create cascading effects that amplify other risk categories and significantly increase total project costs.

Noorzai [17] provides detailed analysis of public-private partnership financial risks in conflict zones, identifying unique financing challenges that emerge when traditional capital markets become disrupted or inaccessible. The research reveals that private sector participation in construction projects becomes severely constrained under war conditions, necessitating alternative financing mechanisms and risk-sharing arrangements.

Insurance and risk transfer mechanisms face particular challenges in war-affected construction environments. The literature documents widespread market failures where standard commercial insurance becomes unavailable or prohibitively expensive [12]. Military risk insurance markets often fail to provide adequate coverage for construction activities, creating significant financial exposure for project stakeholders.

Choudhry et al. [16] examine energy sector construction projects during wartime and recommend specialized military-risk insurance mechanisms combined with international financing partnerships to maintain project viability. Their analysis suggests that traditional insurance models require fundamental restructuring to address the unique risk profiles of wartime construction.

2.4. Theoretical foundations and conceptual frameworks: Risk theory in conflict contexts-time extension and schedule risk analysis

Time-related risks in construction projects under war conditions operate through multiple interconnected mechanisms that create both direct delays and systemic schedule uncertainties. The literature identifies several key pathways through which conflict conditions impact project duration and scheduling reliability. Movement restrictions and security protocols represent primary drivers of schedule disruption. Alashwal [11] document how security requirements create systematic delays in material delivery, workforce mobility, and inspection processes in Yemen construction projects. Their empirical analysis reveals that security-related delays can extend project durations by 25-50% beyond baseline schedules. Supply chain disruptions constitute another major source of schedule risk, as war conditions frequently interrupt normal procurement and delivery systems. Mohammad [3] analyze construction project management in terrorism-affected areas and identify supply chain vulnerability as a critical factor in schedule performance. The research demonstrates that projects with longer supply chains and greater dependence on imported materials face exponentially higher schedule risks.

Project suspension and restart cycles create particular challenges for schedule management in war conditions. Demirci et al. [18] provide comprehensive analysis of suspension risks in public infrastructure projects, identifying the complex financial and scheduling implications of temporary project halts. Their research reveals that suspension events create non-linear schedule impacts, where restart delays often exceed the duration of the suspension period itself. The literature emphasizes that suspension risks are particularly acute in conflict environments where security conditions can change rapidly and unpredictably. Projects must maintain capability for rapid shutdown and restart, which requires specialized planning approaches and resource management strategies.

Human resource availability represents a critical constraint on schedule performance in war-affected construction projects. Anwar [19] examine the effects of varying factors on construction project performance in terrorism-affected areas, identifying workforce availability and skill retention as primary schedule risk factors. The research demonstrates that conflict conditions create systematic workforce disruptions through evacuation requirements, security concerns, and broader economic displacement. The literature also documents significant challenges in maintaining technical expertise and specialized skills during extended conflict periods. Projects often face degraded capability in critical technical areas, necessitating alternative approaches to maintain schedule performance.

Nevertheless, wartime conditions also elevate risks related to quality degradation, scope adjustments, and safety incidents; however, these outcomes are often reported qualitatively or indirectly and therefore remain less consistently operationalized in the empirical literature compared to cost and schedule impacts.

2.5. Risk assessment methodologies and mitigation techniques appropriate for contingent circumstances

The literature presents various quantitative methodologies for assessing construction risks under war conditions, though researchers emphasize that traditional probabilistic models require significant adaptation for conflict environments. Sonmez [20] developed quantitative methodology for cost contingency determination in international projects, providing frameworks that can be adapted for conflict-specific risk assessment.

Senić [21] advanced the field through development of fuzzy logic models for risk quantification in road infrastructure projects. Their Sugeno model approach provides improved prediction accuracy for extension of time and contract price increases, demonstrating the value of hybrid quantitative-qualitative assessment methods in uncertain environments.

Monte Carlo simulation approaches receive extensive attention in the literature as tools for probabilistic risk

assessment. Choudhry [16] demonstrated the application of Monte Carlo methods for cost and schedule risk analysis, though they emphasize the need for careful parameter estimation in conflict environments where historical data may be limited or unreliable.

Qualitative risk assessment approaches gain particular importance in war conditions where quantitative data may be scarce or unreliable. Rashid [14] developed stakeholder-informed frameworks that capture context-specific risk perceptions and implementation constraints in conflict zones. These approaches enable prioritization of movement restrictions, policy implementation failures, and resource availability risks that may not be adequately captured through quantitative methods alone.

The literature emphasizes the importance of integrating local knowledge and cultural understanding into risk assessment processes. Stakeholder engagement approaches must account for the complex social and political dynamics that influence risk perception and management in conflict-affected environments.

2.6. Risk mitigation strategies

Contractual risk mitigation strategies receive extensive attention in the literature, with researchers emphasizing the critical importance of precise force majeure and suspension clause drafting. Hansen [4] provides detailed analysis of contractual implications, demonstrating that standard construction contracts often inadequately address war-related risks and require specialized provisions for notification procedures, risk allocation, and dispute resolution.

The literature consistently recommends transparent payment mechanisms and escrow arrangements to address liquidity risks and delayed progress payments. These contractual tools help maintain project cash flow and reduce financial exposure for both owners and contractors in uncertain environments.

Financial risk mitigation strategies encompass specialized insurance arrangements, currency hedging mechanisms, and alternative financing structures. The literature recommends dedicated military-risk insurance programs combined with international donor guarantees to mobilize private capital for construction projects in conflict zones [12].

Currency hedging and dynamic financial planning approaches receive particular attention as tools for managing macroeconomic risks. Hodiamont [5] examined financial security strategies under war conditions and recommend adaptive budgeting systems that can accommodate rapid changes in economic conditions.

Operational risk mitigation strategies emphasize tactical project management approaches that prioritize adaptability and rapid response capability. The literature recommends shortened planning cycles, frequent re-planning processes, and redundant communication systems to maintain project continuity under military threats.

Modular construction approaches and local sourcing strategies receive attention as methods for reducing supply chain vulnerability. Where feasible, increased local procurement and pre-fabrication can reduce exposure to long supply lines that are vulnerable to disruption during conflicts.

2.7. Summary of identified risks in wartime construction projects

Synthesizing across these studies, several categories of risks emerge in construction under war conditions:

- Political & Security Risks – regime changes, armed attacks, sabotage, insurgency [4].
- Supply Chain Risks – damaged logistics infrastructure, material shortages, inflation [7].
- Financial & Contractual Risks – inflation, investor withdrawal, insurance exclusions, disputes over force majeure [4, 9].
- Operational & Workforce Risks – labour migration, displacement, site shutdowns due to curfews or security measures [8].
- Technological Risks – weak digital infrastructure, and disruptions in Building Information Modeling (BIM) systems under unstable networks [11, 22, 23].
- Environmental Risks – hazardous rubble, toxic debris, sustainability trade-offs [7, 24].

The literature collectively suggests that wartime construction risks extend beyond conventional project management risk categories that primarily affect core project objectives such as cost, time, and quality. Under conflict conditions, however, risk exposure expands to additional objectives that are critical for project viability, including safety and security of personnel, site accessibility and continuity of operations, protection of assets and critical infrastructure, and stakeholder coordination under disrupted governance. In this sense, conflict-driven risks do not replace the traditional success criteria; rather, they intensify cost and schedule uncertainty while simultaneously introducing security- and resilience-related constraints. Accordingly, studies converge on the view that resilience, adaptability, and context-specific frameworks are essential for managing construction projects in active war environments.

Despite the growing body of research on construction projects in conflict-affected environments, the literature remains largely concentrated on projects executed within active combat zones or post-conflict reconstruction settings. As a result, there is limited empirical understanding of how large-scale projects continue to operate under non-kinetic yet systemic conflict conditions, where risks are primarily transmitted through sanctions, market fragmentation, financial restrictions, and technological isolation rather than direct physical destruction. Moreover, existing studies often discuss risk factors in isolation, providing less clarity on how multiple risk domains interact and materialize simultaneously at the project level. Addressing this gap, the present study synthesizes three decades of research to develop a

multidimensional wartime risk typology and applies it to an in-depth EPC case study (Moscow Headquarters Project) executed during the Russia–Ukraine conflict. By comparing literature-based risk manifestations with observed project evidence, the study demonstrates how indirect conflict-driven disruptions reshape cost, schedule, and broader project viability objectives, thereby offering context-specific insights and actionable guidance for contractors operating under prolonged geopolitical and economic instability.

3. Methodology

This study adopts a structured qualitative content analysis approach to identify, code, and classify construction project risks reported in both peacetime and wartime contexts. The methodological workflow consists of three main stages: (1) literature mapping, (2) risk identification and coding, and (3) risk classification into thematic categories. The objective is to develop a comparable risk typology that captures both conventional risk groups and conflict-driven risk dynamics.

3.1. Literature mapping

A systematic literature mapping was conducted to collect academic studies addressing construction project risks under general conditions and under war-related environments (including active conflict and post-conflict settings). The search covered the period 1995–2024 and targeted peer-reviewed journal articles, conference papers, and relevant reports. Studies were screened based on relevance to construction project risk management and inclusion of explicit risk factors (e.g., causes of delay, cost escalation drivers, safety/security disruptions).

3.2. Risk identification

After finalizing the literature set, reported risk factors were extracted from each study. The extracted risks were coded using an iterative coding process. Similar risk expressions across different studies (e.g., “material shortage,” “procurement interruption,” and “import restrictions”) were consolidated under a common risk label to ensure consistency. This step enabled the creation of a harmonized list of risk factors reported across different geographic and contextual settings.

3.3. Risk classification

To avoid conceptual ambiguity, this study distinguishes between risk categorization and risk classification. Risk categorization refers to grouping extracted risk statements into broader thematic clusters based on semantic similarity (e.g., grouping “currency fluctuation” and “inflation” under financial instability). Risk classification, in contrast, refers to assigning these categorized risks into a predefined typology to enable structured comparison across contexts. In this study, risks were classified into six main categories: Political & Security, Supply Chain, Financial & Contractual, Operational & Workforce, Technological, and Environmental.

Workflow of Risk Categorization:

1. Literature review (general + wartime sources)
2. Extraction of risks mentioned in studies
3. Grouping into six main categories
4. Verification of overlaps across contexts
5. Development of Fig. 1.

3.3.1. Political and security risks

Construction projects in active war zones face significant political and security risks, including regime changes, sanctions, and direct armed threats. These conditions endanger both personnel and physical assets, often requiring protective measures.

Example Studies: Ullal [6] noted insurgency-driven disruptions in Afghanistan; emphasized how military involvement altered construction management during counterinsurgency operations.

3.3.2. Supply chain and logistics disruptions

Armed conflict severely affects transportation networks and access to critical materials, leading to shortages and volatile pricing.

Example Studies: Ivanova [7] identified supply bottlenecks in Ukraine under martial law; reported material scarcity and rising costs in conflict-driven construction environments.

3.3.3. Labour and workforce challenges

Conflict triggers migration, conscription, and safety concerns, reducing the availability of skilled labour and displacing local communities.

Example Studies: Lyubchenko [8] documented workforce instability during emergency restoration in Ukraine; Ullal [6] highlighted workforce mobility issues in Afghanistan.

3.3.4. Financial and contractual risks

Wartime uncertainty drives inflation, insurance exclusions, and investor withdrawal. Force majeure clauses often fail to address the complexities of active conflict.

Example Studies: Hansen [4] analyzed contractual disputes arising from war conditions; Kremers [9] discussed civil-military contracting challenges in fragile environments.

3.3.5. Technological and environmental risks

Technological resilience becomes critical under unstable communication and digital infrastructures. At the same time, environmental hazards from debris and hazardous rubble complicate site operations.

Example Studies: Alashwal [11] explored the application of innovative construction technologies under “special conditions”; Lyubchenko [8] stressed environmental hazards in emergency repair.

Rather than introducing entirely unique categories of risk, wartime conditions intensify conventional construction risks by increasing their severity, unpredictability, and interdependence with security-related disruptions. Table 1 summarizes the major categories of risks identified in wartime construction projects and synthesizes the findings reported across the reviewed literature. As shown in Table 1, wartime conditions affect multiple dimensions of construction project performance, including political, operational, financial, technological, and environmental aspects.

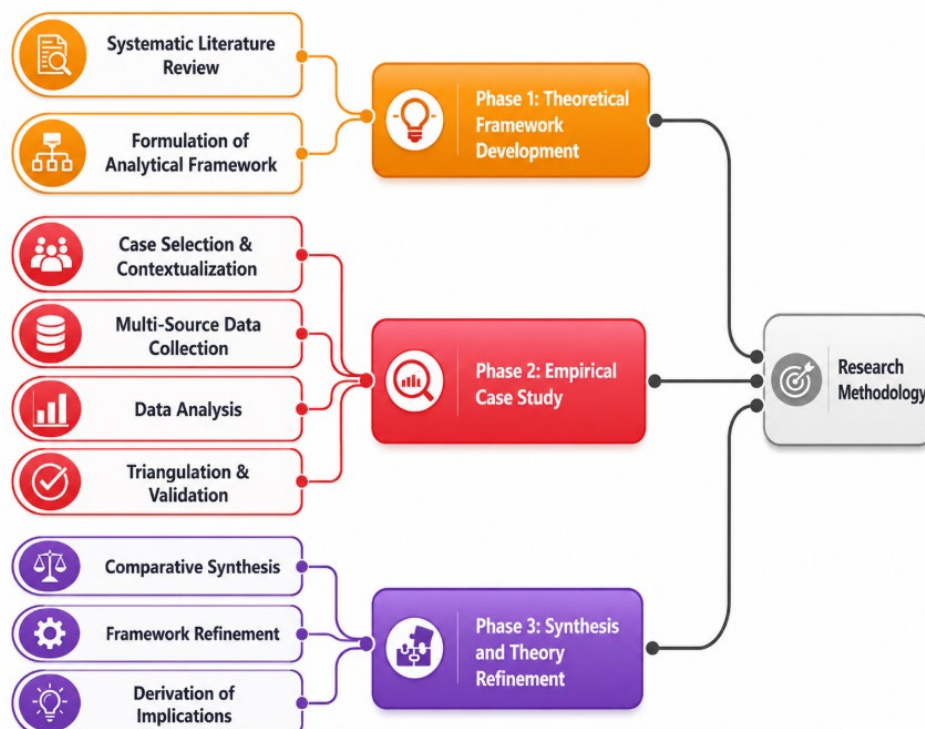


Fig. 1. Methodology for risk categorisation employs these key themes from the literature and the structure of the study formed accordingly

Table 1. Risk typology in construction projects under war conditions

Category	Risks Identified	Supporting Literature
Political & Security	Regime change, sanctions, armed conflict, terrorism, sabotage	[6]
Supply Chain	Infrastructure destruction, shortages of cement/fuel/steel, volatile prices	[7]
Financial & Contractual	Inflation, funding withdrawal, insurance exclusions, force majeure disputes	[5, 9, 12]
Operational & Workforce	Labour shortages, displacement, curfews, site shutdowns	[6, 8]
Technological	Weak digital infrastructure, BIM reliance under unstable networks, limited technological innovation	[22, 23]
Environmental	Hazardous rubble, toxic debris, sustainability trade-offs	[24, 8]

4. Case Study: Moscow Headquarters Project — Building the Campus for a Leading Russian Tech Firm

In December 2021, a major Russian technology company (hereafter “the Client”) commissioned the design and construction of a new flagship headquarters campus in Moscow. The project was conceived not only as a means of consolidating dispersed corporate functions and personnel, but also as an architectural expression of institutional identity and a long-term platform for innovation, research, and collaboration. The contract for Engineering, Procurement, and Construction (EPC) was awarded to a large, internationally active contractor (hereafter “the Contractor”), a firm with decades of experience operating in the Russian market and a global portfolio spanning multiple continents. The Contractor provides full EPC services and in-house fabrication capabilities and is consistently listed among the world’s leading international construction firms.

This case study forms part of a broader master’s thesis [24] that investigates how large-scale construction projects operate under contingent circumstances shaped by geopolitical instability, economic sanctions, supply chain fragmentation, and technological isolation. In such environments, conventional construction risk management assumptions such as political predictability, market continuity, and logistical stability often collapse as external shocks disrupt global procurement channels, labor mobility, and access to digital infrastructures. While existing studies have primarily examined post-conflict reconstruction or projects located within active combat zones, comparatively limited attention has been given to projects that continue under indirect yet systemic conflict-induced disruptions.

Contemporary geopolitical conditions increasingly demonstrate that conflict impacts are no longer limited to direct military engagement and physical destruction. Alongside conventional warfare, prolonged geopolitical tensions and strategic operations increasingly manifest through economic sanctions, trade restrictions, financial instability, technological embargoes, and disruptions to international supply chains. These evolving conditions create a new landscape in which construction projects may

experience wartime-like constraints even outside active combat zones.

In this context, the Moscow Headquarters Project represents a relevant case because, although it was geographically removed from direct hostilities, it remained exposed to conflict-induced systemic pressures associated with the Russia–Ukraine war. Unlike projects in Ukraine, where risks largely emerged from physical destruction and direct security threats, the Moscow case primarily experienced indirect consequences, including sanctions-driven procurement constraints, currency volatility, logistical rerouting, workforce instability, and digital restrictions.

To address this gap, the present study develops a multidimensional risk typology based on three decades of literature and applies it to the Moscow Headquarters Project, an ongoing EPC development project, executed during the Russia-Ukraine conflict. Although the project was located outside the direct theatre of hostilities, it experienced significant systemic disruptions including sanctions-driven procurement paralysis, currency volatility, logistical rerouting, workforce instability, and digital embargoes affecting critical software ecosystems. Drawing on project documentation, contractual records, procurement logs, labour data, and claim dossiers, the study examines how these risks materialised in practice and evaluates the contractor’s adaptive responses across traditional performance criteria (cost, time, and quality) as well as broader conflict-sensitive objectives such as operational continuity, stakeholder constraints, and safety/security considerations.

Within this analytical framework, the Moscow headquarters project provides an empirical lens through which the multi-dimensional impacts of the Russia-Ukraine conflict can be examined at the project level. The outbreak of hostilities in February 2022 introduced systemic volatility into nearly every aspect of the project environment, transforming previously stable operational parameters into dynamic sources of risk. The analysis identifies several interrelated domains of disruption-including financial volatility, supply chain fragmentation, technological restrictions, labour instability, and regulatory uncertainty—each exerting direct and indirect effects on project performance. By tracing how these disruptions evolved and how the project team responded through adaptive

management measures, the study seeks to elucidate the mechanisms through which armed conflict reshapes conventional construction risk structures. The following subsections present these key domains of impact in detail, together with the corresponding mitigation strategies developed to sustain continuity and performance under wartime conditions. Project Scope Key Figures can be seen below:

- The contract was signed on 13 December 2021 between the Client and the Contractor.
- The building comprises up to 15 above-ground floors and 5 basement levels.
- The total construction area is ~ 262,000 m² (above + below ground) including terraces, parking, and shared amenities.
- Office space is estimated at ~ 110,000 m², while parking accommodates ~ 1,630 vehicles (including a multi-car parking system).
- The building's envelope features a lightweight façade, clad in metal/titanium panels, aiming both for aesthetic statement and constructability.
- There are multiple wings connected with bridges and open staircases, centered around a luminous "Hub" space, with shared amenities (cafés, museum, indoor green zones) intended to break down silos and stimulate cross-team interaction.
- The Contractor is also responsible for structural steel fabrication: a subcontracting steel firm produced ~ 13,300 tons of structural steel for the project.
- Construction was initially projected to finish (handover) by mid-2024; however, the project was completed and handed over in May 2025.

4.1. Project-level impacts and risk responses under conflict conditions

In the context of wartime construction, "risk" extends beyond the probabilistic interpretation traditionally applied in project management literature. Rather than discrete and measurable events, risks under armed conflict represent dynamic, interconnected processes that evolve in parallel with political and security developments. They manifest not only as threats to cost, schedule, and quality, but as systemic disruptions affecting governance, supply chains, and institutional trust. Consequently, risk in such environments must be understood as a function of both external volatility and internal organizational resilience. It encompasses tangible dimensions—such as material scarcity, labour displacement, and physical damage as well as intangible aspects including uncertainty in regulation, financing, and inter-stakeholder communication. Building on the typologies established in the preceding section, the following case study applies this conceptual framework to a real-world project, illustrating how wartime conditions reshape conventional risk structures and necessitate adaptive management responses.

4.2. Effects of currency fluctuations on site management

This section discusses the operational and financial implications of currency volatility observed during the initial phase of the Russia–Ukraine conflict. While exchange-rate fluctuations, inflation, and currency devaluation can also occur under peacetime conditions, the case study indicates that wartime economic conditions altered the nature of this risk by increasing the magnitude, speed, and unpredictability of price movements, while simultaneously constraining the project's ability to respond through conventional mechanisms such as stable procurement lead times, predictable supplier pricing, and accessible financial hedging instruments. As a result, currency volatility became tightly coupled with sanctions-driven supply disruptions and contractual rigidities, creating a compound risk environment that significantly exceeded typical macroeconomic exposure in stable settings.

The onset of the Russia–Ukraine war in early 2022 resulted in pronounced volatility in the Russian ruble and the euro exchange rates. This instability had a direct and measurable impact on construction projects operating within the affected region. In the examined case, the project's contractual structure involved multiple currencies—primarily euro (EUR) and Russian ruble (RUB) based on the specific type of work and the origin of materials. Once exchange rate fluctuations intensified after February 2022, this dual-currency payment system exposed the project to significant financial risks. Material procurement costs increased markedly, as suppliers adjusted prices to account for the depreciation of the ruble and the uncertainty surrounding import channels. The project site employed approximately 3,000 workers, with wage payments predominantly made in rubles. However, as the ruble sharply depreciated against the U.S. dollar, the real cost of labour, when converted to a stable currency reference, rose considerably. This dynamic placed substantial pressure on the project's cash flow and budget forecasts. During the monthly progress payment evaluations, the impact of exchange rate misalignment became particularly evident. Payments for work items denominated in rubles failed to offset the simultaneous increase in input costs, resulting in financial deficits in several production categories. Similarly, for works contracted in euros, the fixed contractual exchange rate of approximately 75 RUB/EUR became increasingly unfavorable as the market rate diverged sharply from the agreed benchmark. Consequently, these contractual rigidities amplified the project's exposure to currency risk. In summary, the exchange rate volatility that accompanied the escalation of the conflict created a highly unstable financial environment for site operations. It disrupted cost predictability, strained liquidity management, and required continuous financial reassessment to maintain operational continuity. This case highlights how macroeconomic shocks, particularly under wartime conditions, can directly translate into operational, contractual, and financial risks in large-scale construction projects.

During February 2022, as Fig. 2 shows the Russian ruble experienced heightened volatility amid escalating geopolitical tensions preceding the full-scale invasion of Ukraine. As diplomatic negotiations failed and the conflict appeared increasingly inevitable, the currency weakened sharply due to rising uncertainty and capital outflows. Following the invasion on February 24, 2022, the ruble temporarily collapsed, reaching a peak of approximately 130 RUB/USD in early March its lowest value in history. However, within the same month, the Russian government and the Central Bank of Russia implemented a series of emergency measures, including strict capital controls and a sharp interest rate hike, which rapidly stabilized the currency. Consequently, the ruble appreciated significantly by the end of March, illustrating the direct influence of state intervention on short-term exchange rate dynamics.

The Fig. 3 shows the RUB per USD (Russian ruble per US dollar) on a quarterly basis starting from January 2022. The

vertical red dashed line marks February 24, 2022, the date when Russia - Ukraine war began. Immediately after the war began, the ruble sharply depreciated, with the exchange rate rising from around 75 RUB/USD to over 130 RUB/USD in early March 2022 a historical collapse caused by Western sanctions, capital flight, and financial panic. The result of extraordinary state intervention and artificial controls imposed by the Russian government and central bank. The key actions included:

The post-invasion appreciation of the Russian ruble was primarily the result of extraordinary state intervention and artificial controls implemented by the Russian government and the Central Bank of Russia. Following the initial sharp depreciation after February 24, 2022, the authorities introduced strict capital controls, restricting foreign currency transfers abroad and compelling exporters to convert up to 80% of their foreign earnings into rubles.

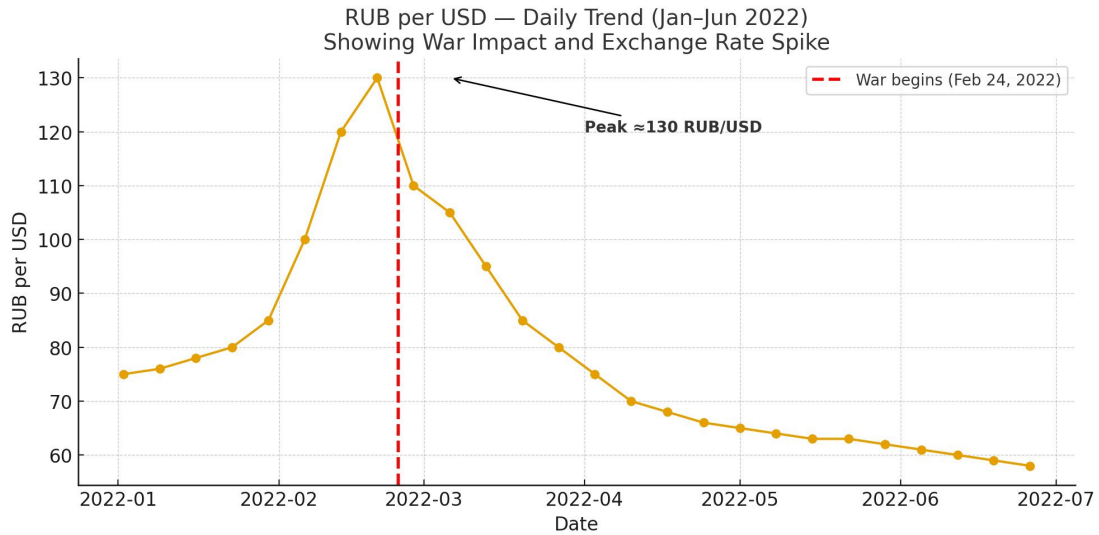


Fig. 2. War impact and Rub-Usd exchange rate spike first 2 quarter period

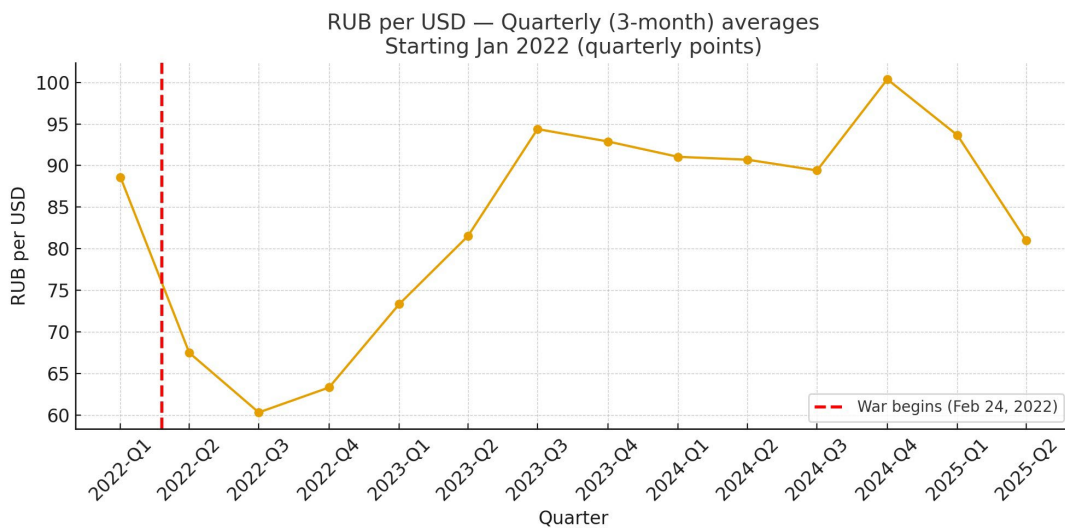


Fig. 3. War impact and Rub-Usd exchange rate averages quarters from January 2022 to February 2025

The key interest rate was simultaneously increased from 9.5% to 20% to stabilize the financial system and discourage speculative attacks on the currency. Despite extensive sanctions, Russia continued to export oil and gas, particularly to China and India, and benefited from elevated global energy prices, which preserved a strong current account surplus. At the same time, imports collapsed due to sanctions and the withdrawal of Western firms, reducing foreign currency demand. These combined measures—along with direct foreign exchange interventions and strict financial regulations—artificially supported the ruble's value. Thus, the currency's recovery reflected policy-driven stabilization rather than genuine market confidence or economic strength.

Compared to typical peacetime volatility, the project experienced three wartime-specific escalation mechanisms:

1. Price formation became disruption-driven, as suppliers revised quotations frequently due to sanctions, import uncertainty, and logistics constraints rather than routine market dynamics.

2. Currency exposure translated into immediate cash-flow stress, because progress payments and cost items were denominated in different currencies under rapidly shifting exchange rates.

3. Contractual rigidity amplified financial losses, as fixed exchange-rate benchmarks and limited adjustment clauses prevented timely rebalancing of cost increases.

4.3. Logistical disruptions and supply chain reconfiguration under wartime conditions

The onset of the Russia–Ukraine conflict in early 2022 triggered severe disruptions across regional logistics networks, significantly affecting the mobility of goods between Europe and the Russian Federation. Traditional transport corridors that previously connected manufacturing hubs in Central and Western Europe to Moscow through Ukrainian territory became inaccessible due to security concerns, airspace closures, and infrastructure damage. Consequently, freight routes were reconfigured through alternative pathways across the Baltic states, Türkiye, and the South Caucasus, resulting in extended transit distances, higher freight costs, and prolonged delivery times [20, 38]. In parallel, sanctions and export restrictions on selected equipment and materials imposed by Western governments further constrained procurement options, compelling contractors to identify substitute suppliers in neutral or allied countries. These adjustments transformed logistics management from a routine coordination task into a high-risk, time-sensitive operation characterized by uncertainty, bureaucratic delays, and escalating costs.

In the case of the Moscow headquarters project, logistical risks manifested through both route reconfiguration and customs bottlenecks. Materials and non-restricted equipment sourced from Europe as mechanical components, façade systems, and specialized finishing materials—could no longer transit via Ukraine, necessitating alternative delivery through

longer southern or northern corridors. These detours added substantial transportation time and increased logistical costs by up to several weeks per shipment. Additionally, because many of the new transit countries intensified customs inspections in response to wartime sanctions, clearance procedures became lengthier and less predictable. Even for legally compliant shipments, extensive document verification and origin tracing were required, causing further schedule deviations. As a result, the project experienced delays in material availability, interruptions in procurement planning, and increased inventory holding costs. This case exemplifies how geopolitical disruptions can propagate through logistics systems, converting regional conflict into operational and financial risks at the project level, and demonstrating the strategic importance of adaptive supply chain management in wartime construction contexts.

4.4. Material supply sanctions and procurement challenges in wartime construction

The imposition of international sanctions following the escalation of the Russia–Ukraine conflict in 2022 profoundly affected the global construction supply chain. A wide coalition of countries—including members of the European Union, the United States, the United Kingdom, Canada, Japan, and South Korea—introduced extensive trade restrictions targeting Russian entities and prohibiting the export of dual-use technologies, industrial equipment, and specialized construction materials [14]. These measures encompassed products from leading Western manufacturers such as Siemens, ABB, Honeywell, Schneider Electric, and others whose systems are widely embedded in high-performance building projects. As a result, ongoing construction activities in Russia faced an abrupt shortage of approved project materials, especially those governed by international design and certification standards. The sanctions not only constrained procurement options but also imposed regulatory ambiguity: even non-restricted products were often delayed or denied due to over-compliance by suppliers and logistical intermediaries. This situation created a cascading effect in project delivery, as substitution decisions required technical reassessment, client approval, and design modification each contributing to significant time loss and potential quality compromise.

In the examined Moscow headquarters project, these constraints were particularly evident in the procurement of electromechanical and façade systems. Several critical components—such as HVAC control units, electrical switchgear, elevators, and building automation devices—were originally specified from Western European suppliers, including Siemens and Schneider Electric. Following the enforcement of sanctions, these firms suspended deliveries and service support to Russia, rendering the approved technical specifications unviable. The contractor was therefore compelled to initiate a comprehensive material substitution process, sourcing alternative equipment from

non-sanctioning countries such as China and Türkiye. However, the integration of these alternatives presented significant engineering and administrative challenges. Compatibility issues with existing system designs required re-engineering of connection interfaces and performance recalculations, while the absence of recognized certifications raised concerns about long-term reliability and warranty compliance. Approval procedures for substitute materials extended project timelines, as each change necessitated coordination with consultants, designers, and client representatives. Consequently, the sanction-driven material shortages not only disrupted procurement efficiency but also reshaped the project's risk landscape, highlighting the vulnerability of globally integrated supply chains to geopolitical shocks and emphasizing the need for resilient, multi-source procurement frameworks in wartime construction environments.

4.5. Continuity of construction during wartime conditions

One of the key risks encountered during the conflict period was the potential disruption of ongoing large-scale construction projects that were deemed strategically important for the national economy. The outbreak of hostilities, the imposition of sanctions, and the withdrawal of certain foreign suppliers created a climate of operational uncertainty. In the examined case, these conditions threatened the continuity of works, particularly given the project's reliance on imported materials, international design coordination, and foreign subcontractors. During the early months of the conflict, procurement schedules were interrupted, delivery times expanded, and several planned imports were delayed or cancelled.

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Despite these challenges, the project managed to maintain overall progress through rapid adaptation and institutional resilience. The contractor implemented a localized procurement strategy, identified alternative suppliers within

domestic and friendly markets, and restructured logistics workflows to comply with emerging restrictions. Strong financial capacity, combined with government prioritization of strategic infrastructure, played a crucial role in preventing extended suspension. Overall, the case illustrates that project continuity under wartime economic conditions depends not only on mitigation actions at the site level but also on the contractor's ability to quantify emerging delays, adjust procurement strategies rapidly, and maintain operational flexibility.

4.6. Workforce stability and labour mobility under wartime conditions

Another significant risk encountered during the project was the instability of the workforce, particularly within the context of wartime uncertainty and changing security conditions. The construction site's labour composition relied heavily on migrant workers from Central Asian countries such as Uzbekistan and Tajikistan, who constituted the majority of the blue-collar workforce. Following the onset of the conflict, heightened security concerns, social tension, and fears of regional escalation generated anxiety among these workers, resulting in short-term absences and a temporary decline in labour availability.

At the same time, the mobilization policies introduced during the conflict created additional challenges for the project's Russian employees. The possibility of conscription among younger male staff members, particularly within technical and engineering roles, introduced further uncertainty into workforce planning and continuity. Moreover, foreign white-collar specialists-particularly those involved in project management, design coordination, and procurement-demonstrated increased hesitation to remain in the country or travel to the site. This collective environment of uncertainty led to a temporary disruption in staffing levels and coordination efficiency during the early stages of the crisis.

In addition to these socio-political challenges, the project faced financial constraints that indirectly amplified labour instability. The sharp depreciation of the ruble and the corresponding increase in import-related costs placed considerable pressure on the project's overall budget. However, during the initial months of the crisis, wage adjustments were not implemented in parallel with currency fluctuations. As a result, real wages-when measured against inflation and exchange rate losses-declined significantly, prompting a portion of the labour force to leave the project in search of more stable or better-compensated employment. This labour attrition generated measurable delays in site productivity and caused progress rates to fall behind the planned schedule.

The delay in restoring the workforce to its original capacity also resulted in additional temporal and financial costs, as certain construction activities could not proceed sequentially as planned. Once wage corrections were

introduced and exchange rate parity was partially restored, the contractor was able to attract and retain skilled labour again, gradually stabilizing manpower levels and bringing production closer to the baseline program. This episode demonstrated the direct interconnection between macroeconomic volatility, wage policy, and project performance under crisis conditions. It further emphasized that timely financial responsiveness-particularly in relation to labour remuneration-can serve as an essential mitigation tool against workforce erosion in large-scale construction projects operating under wartime or sanction-induced economic pressure.

Although comprehensive national statistics on labour mobility by sector were not consistently available for direct comparison within the scope of this study, the findings presented in this section are supported by project documentation and site-level staffing records. Future research may strengthen these conclusions by triangulating project evidence with official labour migration and employment indicators.

4.7. Technological restrictions and the disruption of digital construction systems

Following the escalation of the Russia-Ukraine conflict in early 2022, international technology sanctions extended beyond financial and trade sectors to include digital infrastructure and software access. Major Western software providers such as Autodesk, Bentley Systems, and Trimble-announced the suspension of operations and licensing services in the Russian Federation [23]. These restrictions effectively prevented Russian-based users from accessing or updating critical engineering and design platforms widely used in the construction industry. As a result, ongoing projects faced an unprecedented technological discontinuity: digital workflows dependent on proprietary platforms were disrupted, collaborative data environments became inaccessible, and technical coordination between design and field operations was significantly impaired. This event underscores the emerging category of technological sanctions as a distinct form of wartime risk, capable of undermining both design efficiency and construction management continuity.

Within the examined case project, the technological embargo had a direct and measurable impact on daily construction management activities. The project relied heavily on Autodesk software-specifically AutoCAD for 2D detailing, Revit for Building Information Modelling (BIM), and Naviswork for coordination, progress tracking, and site inspection workflows. These platforms formed the backbone of the project's digital ecosystem, supporting functions such as design review, fabrication drawing approval, and the Non-Conformance Report (NCR) system used for field inspection and quality assurance. Once Autodesk disabled access and licensing renewals for users within the Russian Federation, the project team experienced immediate operational

constraints. File sharing, model synchronization, and issue tracking were interrupted, leading to delays in documentation flow and cross-team communication. In response, the contractor initiated a rapid migration to alternative software solutions, including domestically supported CAD platforms and open-source BIM tools. However, these substitutes lacked full compatibility with existing project data and required extensive reconfiguration and staff retraining. Consequently, the technological restrictions not only introduced delays and inefficiencies but also exposed the project's structural dependency on foreign digital systems-illustrating a critical dimension of vulnerability within wartime construction environments.

5. Comparative Analysis: Literature vs. Case Study Findings

A comparison between the risks identified in the academic literature on wartime construction and those observed in the Moscow Headquarters Project reveals both significant alignments and notable deviations. While the overarching typologies-political and security, supply chain, financial and contractual, operational and workforce, technological, and environmental-remain broadly consistent, the Russian case exhibits distinct patterns arising from its unique geopolitical positioning, sanction environment, and institutional resilience. These differences highlight the contextual specificity of wartime risk manifestation and underscore the need to interpret "war-related" risks not as universally applicable categories, but as context-dependent phenomena shaped by each conflict's political economy and regulatory landscape.

5.1. Convergences with the literature

An important question arising from the case study is whether the major wartime-related risk factors were foreseeable prior to execution or whether they emerged as unforeseen shocks requiring reactive management. Evidence from project documentation indicates that some risks-such as currency volatility, supply delays, and workforce instability-were partially recognizable as generic project risks, although their magnitude and interdependence were not anticipated under normal assumptions. In contrast, sanctions-driven restrictions on procurement channels and disruptions to digital construction ecosystems constituted largely unprecedented risks for the project context, requiring rapid adaptation rather than pre-planned responses. Accordingly, the contractor's risk management evolved from conventional mitigation measures to crisis-oriented strategies as the conflict escalated, highlighting the dynamic nature of the project risk register under contingent circumstances. The empirical findings from the Moscow Headquarters Project corroborate several risk categories widely discussed in the literature on wartime construction, including studies conducted in Afghanistan, Iraq, Syria, and Ukraine.

First, supply chain disruptions emerged as a dominant and immediate challenge. Consistent with Anwar et al. [19], the reconfiguration of logistics routes, prolonged customs inspections, and material scarcity reflected broader patterns of infrastructure fragmentation observed in conflict-affected contexts. The Moscow case further demonstrates that geopolitical constraints, even in the absence of active combat within the country, can propagate similar operational bottlenecks.

Second, currency volatility and inflationary pressures, as highlighted by Choudhry et al. [16] and Kassem et al. [22], manifested acutely through the ruble's sharp depreciation and subsequent state-driven stabilization measures. These macroeconomic fluctuations directly impacted contractual execution, cash flow management, and labour remuneration, confirming the literature's emphasis on financial instability as a central wartime risk.

Third, workforce instability was observed, driven by migration uncertainty, mobilization policies, and wage devaluation. Consistent with the findings of Kremers et al. [9], labour mobility constraints, even in a non-combat zone, materially affected project progress through indirect socio-economic channels.

Finally, technological risks are particularly associated with the sudden loss of access to digital infrastructure and design software. Consistent with Sonmez et al. [20], technology-dependent project delivery systems become highly vulnerable under conflict conditions. In this context, the disruption of Autodesk and other Western software licenses introduced a distinct form of technological risk, demonstrating how sanctions and digital embargoes can mirror the functional impacts of physical infrastructure disruptions on project coordination, quality control, and documentation workflows.

5.2. Divergences and context-specific features

Despite these alignments, several distinct deviations emerged that differentiate the Russian case from typical wartime construction contexts discussed in the literature. Most notably, the absence of direct physical conflict within Russian territory meant that the project's risk profile was dominated by economic and geopolitical sanctions rather than by security or infrastructure destruction. In contrast to cases such as Ukraine, Afghanistan, or Syria—where physical damage and security risks constrained mobility and safety—the Moscow project's disruptions were predominantly systemic: financial, logistical, and regulatory in nature. This divergence indicates that wartime conditions can impose profound project-level risks even without direct exposure to armed violence.

A second major difference concerns institutional and financial resilience. The Moscow project benefited from strong financial capacity, sustained client funding, and government prioritization, allowing continuity despite severe external shocks. Such resilience contrasts with the fragile

institutional environments described [6, 17] where governance collapse and funding withdrawal frequently halted construction activity. The ability of the contractor to localize procurement, restructure logistics, and maintain payrolls underscores the buffering role of capital adequacy and state policy in moderating wartime risk intensity.

A third distinctive dimension concerns sanction-induced material and technological substitution. While literature on wartime construction often addresses material shortages due to destruction or import blockades, the Russian case demonstrates a different mechanism: the withdrawal of Western corporate participation due to sanctions and voluntary market exit. The resulting need to replace high-specification components (e.g., Siemens, Schneider Electric) with alternative systems from non-sanctioning countries introduced new layers of engineering, certification, and quality control risk not extensively covered in prior studies. This phenomenon represents a hybrid between supply chain and technological risk categories and suggests an emergent typology sanction-induced substitution risk that bridges procurement and design domains.

Finally, while environmental risks were central in post-war reconstruction literature [24], such concerns were largely absent in the Moscow case. This absence underscores that environmental hazards are context-dependent, typically materializing in post-conflict reconstruction zones rather than in economies under sanctions but not active bombardment.

5.3. Implications for risk theory and management practice

The comparative findings suggest that wartime risk frameworks must evolve to incorporate the non-kinetic dimensions of conflict—not only the direct physical consequences of warfare, but also the systemic ripple effects of economic sanctions, digital embargoes, and financial countermeasures. Traditional typologies capture the external threats of war, yet understate how policy-driven restrictions and market reorientation reshape internal project dynamics. The Moscow headquarters case illustrates that, in modern conflicts, risks can emerge through regulatory isolation and technological decoupling as much as through material destruction.

Moreover, the project's adaptive strategies—localized sourcing, digital migration, and financial stabilization—demonstrate a form of organizational resilience absent from much of the conflict-zone literature, which often portrays projects as passive victims of instability. This case therefore expands the conceptual understanding of “construction under conflict” to include scenarios of economic warfare, revealing how global interdependencies transform the boundaries of wartime risk.

5.4. Summary of construction risks: Literature vs. case study

To consolidate the findings of the literature review and the Moscow Headquarters case study, Table 2. provides a structured comparison across the six risk categories developed in this study. For each category, the table summarizes (1) how the risk is typically manifested in wartime construction as reported in the literature, (2) how it materialized in the case study context, and (3) the distinctive, context-specific features observed under sanctions-driven and non-kinetic conflict conditions. This comparison highlights both areas of convergence with prior studies and the ways in which indirect, systemic disruptions reshape risk pathways even outside active combat zones.

As the Table 2 illustrates, five of the six risk categories documented in the literature were present in the Moscow Headquarters Project but expressed through indirect, systemic channels rather than direct war damage.

The project's experience expands the theoretical model of wartime construction risk to encompass conditions of economic warfare and digital isolation, where sanctions, financial controls, and technology embargoes replace traditional security threats as primary risk drivers.

This suggests that contemporary "wartime" construction risks can no longer be understood solely in terms of physical insecurity, but must also include macro-financial, regulatory, and technological disconnections arising from globalized conflict dynamics.

6. Field-Level Adaptations and Managerial Responses

Following the onset of the Russia–Ukraine conflict and the subsequent disruptions analyzed in the preceding section, the Moscow Headquarters project entered a critical phase of operational adaptation.

Table 2. Comparative synthesis of wartime construction risks: Literature vs. Moscow Headquarters Project findings

Risk category (from literature)	Typical manifestation in wartime construction (literature review)	Observed manifestation in moscow headquarters project	Distinctive / context-specific features
1. Political & security risks	Regime change, armed conflict, physical destruction of infrastructure, safety threats to personnel [5, 19]	No direct security threats or physical destruction; risks were indirect, stemming from geopolitical sanctions and policy isolation.	External risks emerged through sanctions rather than warfare; political isolation was the main disruptor.
2. Supply chain & logistics risks	Damage to transport networks, restricted mobility, material shortages, rising costs [20]	Traditional European transit routes through Ukraine became inaccessible; alternative routes via Türkiye and the Caucasus increased cost and delivery time. Customs inspections caused major delays.	Logistical disruption shifted from physical insecurity to regulatory constraints.
3. Financial & contractual risks	Inflation, investor withdrawal, insurance exclusions, force majeure disputes [15, 24]	Severe currency volatility (RUB/EUR, RUB/USD), delayed progress payments, contract rigidity on exchange rates, and rising import costs.	Financial instability stemmed from sanctions, while state controls partially stabilized markets.
4. Operational & workforce risks	Labour displacement, safety concerns, curfews, site shutdowns [5, 7]	Decline in migrant workforce (Central Asia) due to security anxiety and currency depreciation; conscription risk for Russian staff; foreign specialists' withdrawal.	Indirect labour loss from economic pressure, not armed threat. Mitigated through wage adjustment and retention incentives.
5. Technological risks	Unstable communication, limited innovation, BIM dependency under poor infrastructure [22, 23]	Loss of access to Autodesk and other Western software licenses; Revit, AutoCAD, and Navisworks workflows disrupted; forced migration to local/open-source platforms.	Introduced new subcategory: technological sanctions risk—digital embargo as a project-level disruptor of design, inspection, and coordination systems.
6. Environmental risks	Hazardous rubble, pollution, post-conflict waste management, sustainability trade-offs [7, 24]	No direct environmental hazards; site operations unaffected by physical damage.	Environmental risks were absent—project took place in a non-combat zone, emphasizing that wartime economic conditions differ from post-conflict reconstruction.

While the initial months of the war introduced substantial uncertainty across financial, logistical, and technological domains, the project’s continuity ultimately depended on the Contractor’s capacity to develop rapid, context-specific mitigation strategies. The following subsections detail the principal field-level interventions implemented between mid-2022 and early-2024, illustrating how a combination of technological substitution, strategic alignment, financial control, and workforce reorganization enabled the project to sustain progress despite unprecedented constraints. These adaptive measures demonstrate the practical translation of risk management theory into organizational resilience at the site level at Fig. 4.

6.1. Technological sanctions and software substitution strategies

The imposition of international technology sanctions in early 2022 resulted in the suspension of licenses for several widely used Autodesk platforms—including AutoCAD, Revit, BIM 360, and Navisworks—within the Russian Federation. This immediately disrupted the digital infrastructure underpinning the project’s design coordination, documentation control, and inspection systems, all of which had relied on Autodesk software.

In response, the Contractor initiated an accelerated transition to alternative solutions. A locally developed CAD application replaced AutoCAD as the primary drafting tool, enabling design teams to resume documentation workflows within a sanction-compliant environment. Simultaneously, all

cloud storage and file-sharing operations were migrated to Yandex Cloud, a Russian-developed platform capable of sustaining large-scale collaborative data management.

To compensate for the loss of integrated inspection and non-conformance reporting tools previously hosted on BIM 360, the Contractor’s IT division developed a proprietary document management and workflow system. This internally engineered software supported field inspection, NCR tracking, and quality documentation processes, thereby maintaining the project’s operational continuity. The transition required extensive staff retraining and data migration, causing short-term productivity losses; however, the adaptation ultimately secured compliance with sanction constraints while preserving essential digital and coordination capabilities.

6.2. Strategic continuity and political endorsement under wartime conditions

As the Russia–Ukraine conflict escalated, strategic infrastructure and technology projects within the Russian Federation gained heightened political and institutional significance. The Moscow Headquarters project—commissioned by a leading national technology corporation—was classified as a priority investment due to its symbolic and functional role in supporting domestic innovation capacity.

Despite initial uncertainty in the financial and geopolitical environment, both the Client and federal authorities reaffirmed their commitment to maintaining uninterrupted project execution.

Moscow Headquarters Project: Adaptation Strategies

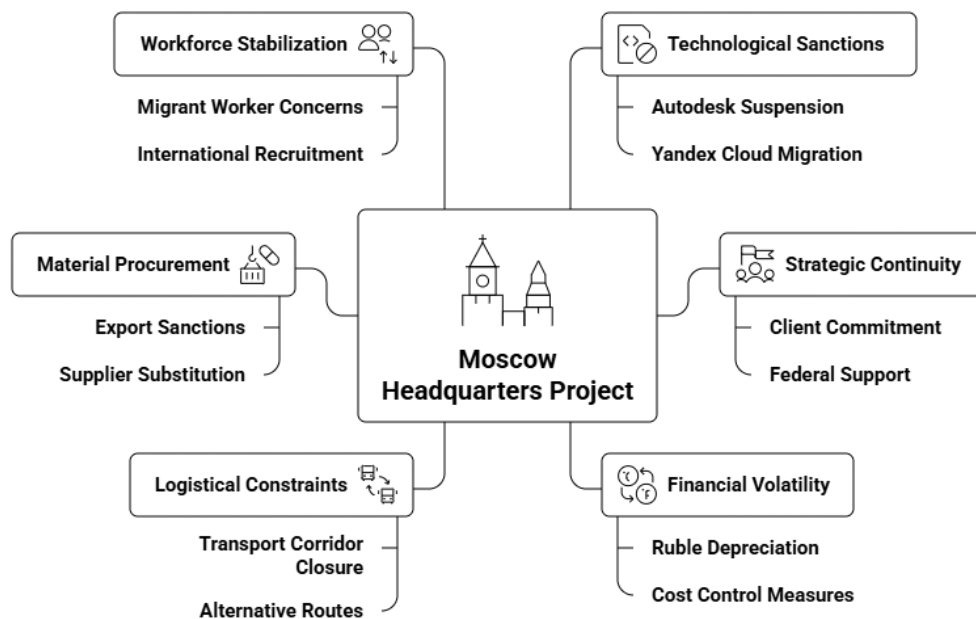


Fig. 4. Visual synthesis of wartime construction risks as manifested in the Moscow Headquarters Project, highlighting indirect, sanctions-driven disruptions across six core categories

The Client continued to meet its financial obligations under the EPC contract, ensuring stable payment flows and resource availability. This alignment between state and corporate priorities reflected a deliberate policy to sustain major capital projects as instruments of economic resilience and political continuity.

For the Contractor, this institutional backing translated into a directive to maintain project momentum under accelerated timelines. The execution strategy was reoriented toward schedule adherence, resource optimization, and visible progress milestones, positioning the project as a demonstration of resilience and stability amid wartime uncertainty.

6.3. Financial volatility and exchange rate management

Currency volatility represented one of the most immediate and disruptive consequences of the conflict. Following the invasion in February 2022, the Russian ruble experienced an unprecedented collapse—depreciating to approximately 130 RUB/USD in early March—followed by a rapid rebound to below 70 RUB/USD within weeks. This extreme fluctuation destabilized contractual and cost-control mechanisms, particularly those involving payments denominated in both rubles and euros.

Local suppliers frequently revised prices in response to market uncertainty, undermining budget forecasts and eroding cost predictability. At the same time, ruble-denominated wages lost purchasing power when benchmarked against foreign currencies, creating additional financial strain for the Contractor's multinational accounting and reporting systems.

As monetary policy interventions by the Central Bank of Russia gradually stabilized the currency, the Contractor adopted a revised financial strategy emphasizing ruble-based transactions, shorter payment intervals, and real-time cost tracking. These measures reestablished a level of fiscal control and mitigated exposure to ongoing currency volatility, allowing more accurate forecasting and improved budget management in later project stages.

6.4. Logistical constraints and supply route reconfiguration

The closure of major European transport corridors—particularly those passing through Ukraine—had a profound effect on project logistics. Airspace restrictions, sanctions on carriers, and overland transit limitations severed traditional supply chains connecting Moscow to European suppliers. As a result, alternative logistics routes were established through Türkiye, Kazakhstan, and the Caspian corridor.

These alternative pathways extended transit durations by a factor of five to six compared to pre-war conditions and significantly increased freight costs. To mitigate the resulting schedule risks, the Contractor implemented an advanced procurement framework based on early ordering, inventory

buffering, and multi-route planning. Materials and equipment were ordered months in advance to account for customs bottlenecks and extended clearance times.

Despite these measures, shipments often faced delays of up to six weeks due to inspection procedures and supplier-side administrative inefficiencies. The Contractor's global logistics offices played a crucial role in coordinating multi-jurisdictional customs compliance and securing faster turnaround times where possible. This adaptive logistical strategy exemplified the project's ability to sustain progress through proactive supply chain reconfiguration amid unprecedented geopolitical constraints.

6.5. Material procurement challenges under international sanctions

The introduction of comprehensive export sanctions by the European Union, the United States, the United Kingdom, Canada, Japan, and South Korea severely restricted the importation of building systems, mechanical equipment, and specialized materials to the Russian Federation. Many of these sanctioned products were specified in the project's approved vendor list, which included European and American manufacturers such as Siemens.

The unavailability of these pre-approved products necessitated rapid re-engineering of the project's procurement strategy. The Contractor, in coordination with the Client and design consultants, identified alternative suppliers in Türkiye, China, and Kazakhstan capable of producing equivalent materials within similar technical and quality parameters.

One notable example involved the façade system: titanium-coated panels originally sourced from a U.S. supplier were redesigned and reproduced by a Chinese manufacturer following rigorous sample testing and performance validation. While these substitutions introduced schedule delays due to testing and re-approval processes, they ultimately maintained project quality standards and contractual compliance. The Contractor's international network of offices facilitated rapid market research, comparative analysis, and supply negotiation, demonstrating the advantages of a globally integrated procurement framework under crisis conditions.

6.6. Workforce stabilization and cost optimization

Labour dynamics during the early conflict period reflected both social uncertainty and macroeconomic turbulence. The project's labour force, composed primarily of migrant workers from Central Asian countries such as Uzbekistan, Tajikistan, and Kyrgyzstan, initially experienced disruptions due to travel concerns, currency depreciation, and uncertainty regarding Russia's internal stability.

Governmental assurances and policy interventions, however, helped restore workforce confidence and normalize site operations. The Contractor simultaneously addressed labour cost volatility caused by fluctuating exchange rates and

rising domestic prices. To balance labour expenses and productivity, the company expanded its international recruitment strategy, mobilizing skilled workers from India through its regional office network.

While the integration of new labour groups required additional time for training and adaptation, the initiative proved financially advantageous, reducing overall labour costs while sustaining production capacity. This approach underscored the Contractor's capacity to leverage its multinational presence to mitigate localized economic pressures and maintain workforce stability under conflict-affected conditions.

7. Conclusions

Wartime risks are multidimensional and encompass political and security threats, supply chain disruptions, financial uncertainties, workforce instability, technological challenges, and environmental hazards. Project continuity during conflict relies heavily on financial robustness and government prioritization, which can mitigate risks and prevent project suspension even amidst active hostilities. Workforce instability is a significant challenge during wartime, driven by security concerns, migrant labor shortages, and workforce mobilization policies, leading to productivity delays and increased project costs. Supply chain vulnerabilities are aggravated by transportation infrastructure damage and material scarcity, necessitating strategies such as local sourcing and modular construction to reduce dependency on long supply lines. Traditional risk management approaches are inadequate in conflict environments; instead, adaptive frameworks that incorporate qualitative assessments, stakeholder engagement, and flexible contractual provisions are essential. Suspension and restart cycles are complex in war zones, with latent schedule risks that require specialized planning and resource management strategies to mitigate delays. Comprehensive mitigation strategies, including contractual clauses for force majeure, international insurance, financial hedging, and technological innovations, are critical for managing economic and operational risks.

The findings also highlight that wartime construction risk is not uniform across countries and is strongly shaped by a project's geopolitical position and proximity to the conflict. The Russia-Ukraine war generated an asymmetric risk landscape: while projects in Ukraine have been exposed to direct kinetic impacts such as physical destruction, security threats, and site access limitations, projects in Russia have experienced predominantly indirect but systemic disruptions driven by sanctions, financial restrictions, market isolation, and technological embargoes. Moreover, countries not directly involved in the war such as European Union member states may still face conflict-induced risks through secondary channels including energy price shocks, regulatory

constraints, supply chain reconfiguration, and heightened market volatility. This broader framing suggests that contemporary wartime risk management should account not only for combat-zone conditions but also for non-kinetic conflict environments where geopolitical and economic mechanisms can disrupt project delivery.

Beyond the immediate impacts of armed conflict, the findings of this study reflect a broader shift in the contemporary global order, where geopolitical competition increasingly manifests through economic sanctions, trade restrictions, financial controls, and technology embargoes. These measures often generate long-lasting and widespread disruptions that extend well beyond the physical boundaries of war zones. The Moscow Headquarters case demonstrates that large-scale construction projects may face "wartime-like" risk conditions even when they are not exposed to direct hostilities, as systemic constraints can reshape procurement access, payment mechanisms, labour availability, and digital project ecosystems. In this sense, the case provides a valuable reference point for future projects expected to operate under similar non-kinetic conflict environments, where indirect geopolitical pressures may become as disruptive as conventional wartime threats. Although the case study is Russia-based and reflects a context-specific exposure to sanctions and isolation dynamics, it offers actionable insights into how contractors can adapt their risk management strategies to maintain project continuity under prolonged and externally imposed constraints.

The findings of this study demonstrate that resilience, adaptability, and context-specific frameworks are essential for ensuring project success under wartime conditions and emphasize the need for industry-wide guidelines tailored to conflict-affected environments. This study emphasizes the significant impact of armed conflict on the management and execution of large-scale construction projects. It has been demonstrated that wartime engenders a complex array of risks that extend beyond traditional project uncertainties, encompassing political instability, security threats, supply chain disruptions, financial volatility, and workforce instability. The empirical analysis of the Moscow headquarters project, undertaken amid the Russia-Ukraine conflict, demonstrates the necessity of adaptive management strategies, resilient contractual frameworks, and localized sourcing approaches to ensure project continuity under extreme conditions. The integration of comprehensive risk classification, proactive mitigation measures, and flexible operational planning is critical for navigating the unpredictable environment of wartime construction. This research emphasizes that successful project delivery in conflict environments depends on the ability to anticipate, adapt to, and mitigate these multifaceted risks. It therefore reinforces the importance of context-specific frameworks that prioritise resilience and agility.

Declarations

Conflict of Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

This research received no external funding.

Author Contributions

M. A. Çolak: Data curation, Conceptualization, Methodology, Investigation, Writing- Original draft, Visualization, Writing- Reviewing and Editing. G. E. Güranlı: Supervision, Project administration, Conceptualization, Methodology, Reviewing and Editing, Visualization.

Acknowledgments

Not applicable.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

Ethics Committee Permission

Not applicable.

Use of Generative AI and AI-assisted Technologies

The authors confirm the authors did not use any AI tools in the preparation of this work OR research OR study.

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