Digitalization of Business Processes as a Factor in Enhancing the Competitiveness of Enterprises during Wartime Recovery in Ukraine

Oleksandr Bradul
Doctor of Economic Sciences,
Professor,
Department of Marketing, Accounting,
Taxation and Public Administration,
Faculty of Economics and Business Management,
Kryvyi Rih National University,
Kryvyi Rih, Ukraine,
e-mail: aleksandrbradul@icloud.com,
ORCID: 0000-0001-9544-2175

Nina Petrukha
PhD in Economics,
Associate Professor,
Department of Management in Construction,
Kyiv National University of Construction
and Architecture, Kyiv, Ukraine,
e-mail: nninna1983@gmail.com,
ORCID: 0000-0002-3805-2215

Ulyana Balyk
PhD, Associate Professor,
Department of Marketing and Logistics,
Institute of Economics and Management,
Lviv Polytechnic National University,
Lviv, Ukraine,
e-mail: ubalyk@gmail.com,
ORCID: 0000-0001-8379-4907

Nataliia Sulima
PhD in Economics,
Associate Professor,
Department of Economics,
Faculty of Economics,
National University of Life and
Environmental Sciences of Ukraine,
Kyiv, Ukraine,
e-mail: sulimanatalia2003@gmail.com,
ORCID: 0000-0002-3852-7989

Ol'ha Kokorieva
PhD in Economics,
Associate Professor,
Department of Management,
Marketing and Tourism,
Faculty of International Economic Relations,
Management and Business,
Kherson National Technical University,
Khmelnytskyi, Ukraine,
e-mail: kokoreva84@ukr.net,
ORCID: 0000-0001-9918-2278

Abstract

The current research investigates whether digitalization (DT) of business processes can increase enterprise competitiveness during wartime recovery in Ukraine. The cross-sectional survey design with retrospective pre post constituents was adopted. Data were collected from 847 Ukrainian enterprises stratified by sector (manufacturing, services, agriculture, IT/logistics) and enterprise size (small, medium, large). Digital Adoption Level (DAL) was measured across five solution categories (automation, CRM, ERP, cloud tools, AI-based analytics) using a composite index. Competitiveness indicators included operational efficiency, cost reduction and market expansion. Multiple linear regression, moderation analysis with interaction terms and subgroup analysis were conducted. Results reveal a strong positive relationship between DT and competitiveness. Moderation analysis shows the effect is strongest for IT/logistics and services sectors and for large enterprises. Subgroup analysis identifies cloud tools and AI-based analytics as most impactful solutions. Pre post comparison reveals that high-digitalization firms had better across all metrics of competitiveness even after the war, whereas low-digitalization firms worsened in all areas. Results reveal five post-war competitiveness mechanisms, which include: flexibility, resilience, efficiency, resource optimization and global market integration. Policymakers ought to redistribute funds towards cloud and AI grants and focus on digital infrastructure. Cloud migration and AI analytics are strategic requirements that businesses need to address.

Keywords: Digital Transformation; Competitiveness; Economic Reconstruction; Firm Competitiveness; Enterprise Resilience; Ukraine.

Introduction

The devastating effects of armed conflict are not limited to humanitarian tragedies but also significant economic displacements. Examples of the consequences of war are the breakdown of supply chains, physical infrastructure damage, the displacement of many people, and almost complete stagnation of productive businesses (Berezutskyi &

Tokhtamysh, 2025). In the case of post-war economies, the need to rebuild does not simply entail the process of restoring pre-conflict conditions, but establishing more resilient, efficient and adaptive economic systems that can withstand future shocks. Digitalization (DT) and technology are now viewed as a necessity condition to achieve sustainable results (Khan et al., 2026). Besides, DT of business processes has also become a potentially disruptive tool to help improve enterprise competitiveness in the process of post-war recovery (Mandych et al., 2024).

The recent post-conflict experiences show how important digital technologies are in economic rebuilding. In Iraq, SMEs using cloud-powered accounting and CRM systems regained operational capacity much quicker than those using physical records (which were destroyed) (Abdullah et al., 2026). The literature proves that adoption of DT is stimulated by external shocks, and the organizational resilience is one of the mediating variables (Őri et al., 2024). The Balkans showed that companies that adopted Industry 4.0 tools also showed faster integration into the global value chains (Shaqiri et al., 2024). Most relevantly, since 2022, Ukraine has been forced to rapidly transform digitally. A survey of 50 small retail businesses in Kyiv area revealed that majority of them are actively using digital tools like online stores, mobile apps, AI and cloud technology, and correlation analysis showed positive connection between the DT and economic recovery (Makedon & Koptilyi, 2025). To keep businesses afloat and keep export routes open, Ukrainian enterprises have turned to remote workflow automation, cloud ERP, and AI-controlled logistics (Krymska et al., 2025). The examples indicate that DT is an essential, rather than a luxury, of post-war competitiveness.

Although this is emerging evidence, there remains a gap in research. The literature on post-war economic recovery has in the past addressed macroeconomic stabilization, FDI, reconstruction of infrastructure and institutional reform (Moore, 2021). There is a paucity of studies that look at firm-level competitiveness in post-conflict rebuilding. In addition, though vast amounts of literature have explored the concept of DT in stable and high-income economies (Verhoef et al., 2021), but minimal empirical studies explored the role of business process DT as a competitive recovery system in post-conflict economies. The recent studies of resilience and in geopolitical uncertainty prove that dynamic capabilities, organizational agility, and digital enablers play a pivotal role in adaptation at firm-level (Malik & Terzidis, 2025). Yet, the majority of the literature concentrates on large multinationals in institutional settings that are stable, and it has a gap in insights about how small and medium firms in war affected areas develop resiliency via DT progress.

It is especially acute in the case of Ukraine, which is a special example of a high-middle-income, highly digitized pre-war economy that experiences wartime acceleration in DT. The recent empirical research confirms that DT has become a strategic answer to the wartime challenges on the side of Ukrainian SMEs, as the digital tools have evolved not only into a competitive edge but also became a necessity to survive (Klietsova et al., 2025). Moreover, a study of Ukrainian companies operating during martial law reveals DT was associated with increasing business resilience and adaptation (Shveda et al., 2024), but still little systematic empirical evidence exists regarding relationship between a particular Digital Adoption Level (DAL) and the results of competitiveness. While Maksymenko et al. (2024) demonstrate that e-commerce has sustained enterprise activity during Ukraine's wartime economic instability; the relationship between digital adoption levels and measurable competitiveness indicators remains unquantified.

Thus, this study considers following research questions that are based on the enterprise-level competitiveness drivers:

1. RQ1: What is the relationship between the degree of business process DT (automation, CRM, ERP, cloud tools, AI analytics) and enterprise competitiveness indicators (operational efficiency, cost reduction, market expansion) in Ukrainian enterprises during wartime recovery?
2. RQ2: How do sector (manufacturing, services, agriculture, IT/logistics) and enterprise size (small, medium, large) moderate the effect of DT on competitiveness?
3. RQ3: Which specific digital solutions provide the greatest competitive advantage in the post-war context,

and through what mechanisms (flexibility, resilience, resource optimization, global market integration)?

The objectives of this study are:

1. To empirically measure the impact of DT on enterprise competitiveness using survey data from Ukrainian firms
2. To identify sector-specific and size-specific digital drivers of recovery
3. To provide recommendations for enterprise managers and policymakers on prioritizing digital investments for post-war economic rebuilding.

So, this study makes an original empirical contribution to the intersection of DT research and post-conflict economics. The results are not only expected to be used in the reconstruction of Ukraine, but also in other economies that have been affected by conflicts and where DT can act as a catalyst to competitive recovery.

After this introduction, Section 2 will give important literature review. Section 3 presents the research design, sample, variables, and methods of analysis. Section 4 contains findings and Section 5 discusses them. The study is concluded in section 6.

Literature Review

Theoretical Foundations

Theoretical framework of present study is based on three overlapping areas, namely: business process DT, enterprise competitiveness, and post-war reconstruction models. Defined as the implementation of DT in business processes to generate value and enhance operational results (Denner et al., 2018), has been theorized using the concept of dynamic capabilities (DC) first of all, is called DT. According to the DC framework by Teece (2018), sensing, seizing, and transforming are fundamental elements that help firms to respond to environmental changes. DT boosts these functions in more stable economies by providing real-time data processing, automating processes, and customer analytics (Broccardo et al., 2024). But in the post-war period, where turbulence of environment is severe, and physical property is destroyed, the relevance of this framework has not been empirically validated.

Cost leadership, differentiation, and focus strategies are traditionally associated with enterprise competitiveness as an ability to maintain a position in market, reach a high level of efficiency, and enter new markets (Porter, 1991, Teece, 2018). DT is claimed to reduce transaction costs, enhance the visibility of the supply chain, and facilitate mass customization (Pech & Vrchota, 2022). Nevertheless, these processes presuppose well-organized infrastructure and consistent institutions which collapse in the post-conflict environment. The post-war reconstruction models that traditionally featured a higher macro level of approaches (reconstruction of the infrastructure, donor assistance, institutional reforms) have started to include firm-level digital strategies only recently (Sitnicka & Serhiienko, 2025). This disconnection is a significant theoretical gap: micro-level DT does not often feature into post-conflict economic recovery patterns.

Empirical Literature

There are three recent models that are specifically useful in the analysis of post-war DT. The 4.0 Industry of the industry, which is based on cyber-physical systems, IoT, cloud computing, and AI, has been popular among manufacturing economies (Jamwal et al., 2025). Firms employing Industry 4.0 tools minimized downtime in a post-conflict setting, like in Bosnia and Herzegovina (Bajrić et al., 2021). Nevertheless, the model presupposes constant electricity supply, the Internet connection, and the availability of skilled workers, which is uncommon in active war zones or those that recent ones are, which contradicts itself. Digital maturity models categorize firms as nascent states, less mature firms and more mature firms and, in stable economies, the more mature firms outperform the less mature ones in terms of profitability (Okeke et al., 2025). However, there is initial evidence in post-war Ukraine indicating that some companies do not follow a non-linear pattern: some have jumped between low pre-war DT and high wartime adoption, bypassing intermediate phases, indicating post-war settings might demand context-specific models of digital maturity that consider forced and rapid adoption under extreme conditions (Dovgal et al., 2021). The theory of crisis-driven innovation suggests that the external shock can increase the pace at which the organization adopts DT due to the disruption of organizational inertia (Netz et al., 2022). Firms all around

the world took up remote work and e-commerce more than ever during the COVID-19 (Lashitew, 2023). Physical destruction in the post-war environment necessitates digital replacement, but there continues to be a gap: the majority of existing crisis-driven innovation research looks at short-term shocks, not long-term conflicts, and it is unclear whether wartime adoption of DT will lead to long-term competitiveness or revert to pre-peace levels (Roieva et al., 2023; Mykhalchenko et al., 2023).

The empirical literature is clustered into three thematic clusters. First, in terms of digital tools, automation saves on the cost of operations (Shivajee et al., 2019), CRM enhances the retention of customers through (Lamrhari et al., 2022; Shpykuliak et al., 2024), and cloud tools scale operations (Abu-El-Haija et al., 2025). In post-conflict Iraqi banking sector where the basic digital tools were the only tools utilized, there was no statistically significant improvement in competitiveness, which implies a threshold effect (Sadraoui et al., 2024). Second, the organizational capacity mediates results: digital literacy, leadership commitment, and change-readiness culture are critical (Li et al., 2023). During the post-war Balkans, companies with a high level of digital skills obtained higher productivity gains due to the implementation of ERP compared to companies with low skills (Durmishi, 2024). On the other hand, wartime labor displacement, in Ukraine, has emptied digital talent pools, compelling companies to turn to remote freelancers and AI-assisted automation, a situation that is a paradox to post-war settings (Korzh et al., 2025). Third, the external environment conditions DT effectiveness. It is a moderating factor in stable economies and a binding constraint in post-war economies (Sun et al., 2026). In eastern Ukraine, companies on cloud systems had intermittent access to their systems through energy infrastructure attacks, necessitating hybrid offline-online, whereas in western Ukraine, companies reported smooth adoption, indicating that research may need to disaggregate by the level of conflict.

Research Gap and Contribution of the Study

There are three key gaps that arise. First, a cohesive framework is lacking connecting DT to post-war competitiveness because current research focuses on each of them and does not clarify how DT transform damaged physical resources into competitive advantages. Second, little empirical data exists in conflict zones, and the majority of studies is based on small samples or qualitative case studies. Third, the literature presumes that there are no differences in the DT effects that are cross-sector and firm-specific, although initial findings in Ukraine indicate otherwise. Although there are theoretical underpinnings (dynamic capabilities, Industry 4.0, digital maturity, and crisis-driven innovation), they have not been adjusted to post-war settings. This paper fills these gaps by empirically investigating, in a large-scale post-war economy, the extent to which DT influences enterprise competitiveness, conditioned by sector, size and intensity of conflict.

Methodology

Research Design and Rationale

This research design is cross-sectional survey design with retrospective pre post features. The cross-sectional design is used since the study focused on measuring current level of DT and the connection between it and the competitiveness indicators among a large number of Ukrainian enterprises during wartime recovery in Ukraine (2023-2025). The retrospective component makes firms to report key performance indicators for two time points: (1) pre-full-scale invasion (2021) and (2) current (2025). This is enabling pre-post DT comparisons despite the absence of a true longitudinal baseline (as many firms lost records during active hostilities).

A pure case study or a qualitative approach was not selected since the research questions are aimed at obtaining generalizable and quantifiable approximations of the association between DAL and measure of competitiveness in different sectors and sizes of firms. Nevertheless, the future research ought to add to these quantitative results with qualitative interviews.

Sample and Data Collection

The study population is the group of all registered enterprises operating in Ukraine as of January 2025, without exception to temporarily occupied regions, where it is not possible to collect reliable data. The sampling frame is the State Statistics Service of Ukraine database of active enterprises ($N \approx 312{,}000$ as of 2025). Stratified random sampling was applied across two dimensions: sector

(manufacturing, services, agriculture, IT/logistics) and enterprise size — small (10–49 employees), medium (50–249), and large (250 or more). Stratification ensures adequate representation of subgroups for moderation analysis. A total of 1,250 enterprises were invited to participate. After excluding incomplete responses and those from actively contested zones, the final sample is N = 847 (response rate 67.8%). This exceeds the minimum required for multiple regression with 15 predictors (minimum n = 150) and provides sufficient power (0.95) to identify small-to-medium effects (Cohen's $f^2 = 0.10$). The 847 enterprises represent 22 regions of Ukraine, with 41% from western regions, 33% from central regions, and 26% from eastern and southern regions, excluding temporarily occupied territories. Data was collected from online survey administered via Ukraine's Diia portal (government digital platform) and direct email to enterprise CEOs/CIOs between January–March 2025. The survey was pilot-tested with 30 enterprises in April 2024, leading to minor wording revisions. Data were anonymized and stored on encrypted servers. Sample proportions reflect the stratification design rather than population weights; therefore, results should be interpreted as conditional on the achieved sample composition.

Variables and Measurement

All variables are operationalized using objective performance metrics drawn from company accounting records, financial statements, CRM data, and customs declarations. The dependent variable is ECI. It is a composite index capturing three dimensions, each measured by two objective indicators (pre- and post- DT, 2021 vs. 2025). The ECI details are given in Table 1.

Table 1: Composition of the Enterprise Competitiveness Index (ECI)

Dimension	Indicator	Measurement
Operational efficiency	Cost per unit output (UAH)	Company accounting data
	Order fulfillment time (days)	Company records
Cost reduction	Total operating costs (% of revenue)	Financial statements
	Logistics cost per shipment (UAH)	Company records
Market expansion	New customer acquisition rate (%)	CRM data
	Export revenue share (%)	Customs declarations

The ECI is calculated as the equally weighted average of the six standardized indicators (z-scores). Higher scores indicate greater competitiveness.

The independent variable of the study is DAL. It is measured as a composite score based on implementation status in which 0 depicts not implemented, 1 show partially implemented and 2 means fully implemented, across five digital solution categories:

- Automation (robotic process automation, workflow automation tools)
- CRM systems (Salesforce, HubSpot, local equivalents)
- ERP systems (SAP, Microsoft Dynamics, 1C:Enterprise)
- Cloud tools (SaaS for accounting, collaboration, storage)
- AI-based analytics (predictive demand forecasting, customer analytics)

DAL ranges from 0 to 10 (sum of scores across five categories). For analysis, DAL is also categorized as Low (0 to 3), Medium (4 to 7), or High (8 to 10).

The study considered the following moderator variables

- Sector: Manufacturing (reference), Services, Agriculture, IT/Logistics (dummy-coded)
- Enterprise size: Small (reference), Medium, Large (dummy-coded)

The control variables of the study are:

- Firm age (years since registration)
- Pre-war DT level (retrospective DAL for 2021, 0–10 scale)
- Access to international donor funding (binary: yes/no)

Analytical Methods

All analyses were conducted using Stata 18.0. In the first step, descriptive statistics and pre-post comparisons were calculated, while paired t-tests compared 2021 and 2025 performance indicators. To address RQ1 on the relationship between DAL and the ECI, the study estimated a multiple linear regression model employing robust standard errors to correct for heteroscedasticity, presented in Equation 1:

$$ECI_i = \beta_0 + \beta_1 DAL_i + \beta_2 Controls_i + \varepsilon_i \quad (1)$$

In the case of RQ2, the moderation analysis was performed by introducing interaction terms (DAL × sector and DAL × size) sequentially, and simple slopes analysis was performed for significant interactions. To answer RQ3 on which DT solutions provide the greatest advantage, subgroup analysis was run as separate regressions for each digital tool category, controlling for other tools; variance inflation factors were checked to ensure no multicollinearity (threshold VIF < 5). Missing data were minimal (less than 5% per variable) and handled via list wise deletion. The ECI scale showed strong internal consistency because Cronbach's alpha was 0.87. A panel of three academics and five business experts validated the content relevance of the survey items. Harman's single-factor test gave single factor that explained only 32% of the total variance, that was under 50% threshold. Harman's single-factor test indicated that one factor explained 32% of total variance, below the 50% threshold, providing preliminary but not conclusive evidence against common method bias. Future research should employ marker-variable techniques for stronger validation.

Ethical Considerations

All participating enterprises were informed and gave consent. No sensitive financial information was gathered, and all performance measures were reported as percent changes or anonymized.

Results

Sample Characteristics

The final sample (N = 847) consists of businesses in each of the four industries and three size groups. The sample distribution is given in Table 2.

Table 2: Sample Distribution by Sector and Enterprise Size

Sector	Small (n)	Medium (n)	Large (n)	Total (N)	% of Sample
Manufacturing	102	78	45	225	26.60%
Services	118	65	32	215	25.40%
Agriculture	95	60	28	183	21.60%
IT/Logistics	85	72	67	224	26.40%
Total	**400**	**275**	**172**	**847**	**100%**

Pre-Post Digitalization Comparisons

Table 3 shows the average performance indicators and standard deviations of 2021 (pre full scale invasion) and 2025 (current) by DAL. All changes are statistically significant at $p < 0.01$ (paired t tests) unless noted.

Table 3: Pre-Post Digitalization Performance Indicators by DAL

Indicator	Year	Low DAL (n=214) Mean (SD)	Medium DAL (n=398) Mean (SD)	High DAL (n=235) Mean (SD)	Δ (High - Low) 2025
Cost per unit output (UAH)	2021	124.5 (18.2)	118.2 (16.5)	115.7 (15.9)	—
	2025	138.7 (22.4)*	112.4 (14.8)**	89.3 (11.2)**	- 49.4 UAH
Order fulfillment time (days)	2021	12.4 (2.8)	11.8 (2.5)	11.2 (2.3)	—

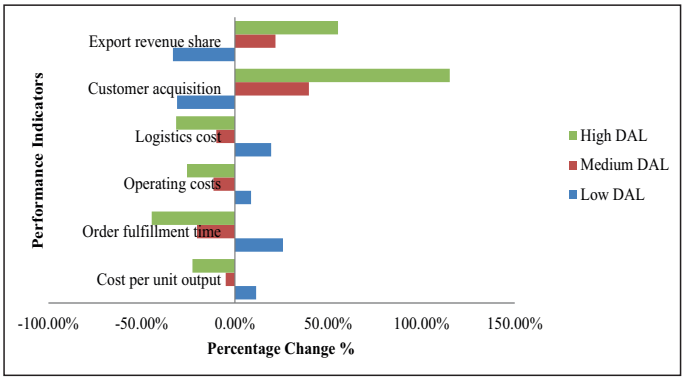
Indicator	Year	Low DAL (n=214) Mean (SD)	Medium DAL (n=398) Mean (SD)	High DAL (n=235) Mean (SD)	Δ (High - Low) 2025
	2025	15.6 (3.5)*	9.4 (1.9)**	6.2 (1.4)**	- 9.4 days
Operating costs (% of revenue)	2021	68.3 (8.5)	65.9 (7.9)	64.1 (7.2)	—
	2025	74.2 (9.8)*	58.3 (6.5)**	47.6 (5.4)**	- 26.6 p.p.
Logistics cost per shipment (UAH)	2021	3,450 (520)	3,210 (480)	3,080 (450)	—
	2025	4,120 (680)*	2,890 (410)**	2,110 (320)**	- 2,010 UAH
New customer acquisition rate (%)	2021	4.2 (1.1)	4.8 (1.3)	5.3 (1.4)	—
	2025	2.9 (0.9)*	6.7 (1.6)**	11.4 (2.3)**	+8.5 p.p.
Export revenue share (%)	2021	18.4 (4.2)	21.2 (4.8)	24.6 (5.1)	—
	2025	12.3 (3.1)*	25.8 (5.2)**	38.2 (6.5)**	+25.9 p.p.

*Notes: *p < 0.05 (worsening compared to 2021); **p < 0.01 (improving compared to 2021). p.p. = percentage points. Low DAL = 0–3; Medium = 4–7; High = 8–10. SD = standard deviation. Δ = difference in 2025 values between High and Low DAL groups.*

Table 3 gives the following observations. Despite the war, High DAL enterprises increased all six indicators in 2021-2025. Low DAL enterprises declined on all measures indicating that without DT, competitiveness declined during the war. The difference between High and Low DAL firms in the year 2025 is 49.4 UAH lower unit costs: the High DAL firms are lower in unit costs by 49.4 UAH, in fulfillment time by 9.4 days and in the export share by 25.9 percentage points.

The data in Figure 1 demonstrates change in performance indicators.

Figure 1: Percentage change in performance indicators (2021–2025) by DAL



Source: Computed from primary survey data (N = 847)

Figure 1 shows the percentage change in performance indicators between 2021 and 2025 by DAL. High DAL companies (score 8-10) improved in all six indicators, and Low DAL companies (score 0-3) became worse in all indicators. Medium DAL companies (score 4-7) were mostly in the middle, improving on five indicators, but deteriorating on cost per unit output. The best increases of High DAL firms can be seen in customer acquisition and export revenue share.

Regression Results: Digital Adoption and Competitiveness (RQ1)

Table 4 presents the multiple linear regression outcomes for ECI as dependent variable). Model 1 includes only DAL and controls, and Model 2 adds sector and size interactions.

Table 4: Linear Regression Results Predicting ECI

Predictor	Model 1 (Main Effects)		Model 2 (With Interactions)	
	β (SE)	p-value	β (SE)	p-value
DAL	0.412 (0.038)	<0.001	0.385 (0.042)	<0.001
Firm age (years)	- 0.023 (0.015)	0.124	- 0.019 (0.014)	0.182
Pre-war DAL (2021)	0.185 (0.029)	<0.001	0.172 (0.028)	<0.001
International donor funding (1=yes)	0.208 (0.041)	<0.001	0.195 (0.039)	<0.001
Sector (ref: Manufacturing)				
Services			0.082 (0.045)	0.068
Agriculture			- 0.054 (0.052)	0.298
IT/Logistics			0.167 (0.048)	<0.001
Size (ref: Small)				
Medium			0.113 (0.044)	0.011
Large			0.201 (0.051)	<0.001
DAL × Services			0.089 (0.041)	0.031
DAL × Agriculture			- 0.032 (0.047)	0.498
DAL × IT/Logistics			0.147 (0.039)	<0.001
DAL × Medium			0.041 (0.038)	0.282
DAL × Large			0.076 (0.042)	0.042
Constant	- 0.284 (0.112)	0.012	- 0.315 (0.118)	0.008
R^2	0.512		0.587	
Adjusted R^2	0.505		0.573	
F-statistic	74.2 (p<0.001)		42.5 (p<0.001)	

Note: N = 847. Standard errors (SE) are robust. All continuous variables standardized before analysis.

Table 4 depicts that there is a strong, positive, statistically significant relationship between DAL and ECI (β = 0.412 in Model 1, $p < 0.001$). The standard deviation of change in competitiveness in response to the increase in DAL by one standard deviation is 0.412, other things held constant. This evidences that DT positively affects the post-war enterprise competitiveness.

The interaction terms in Model 2 indicate differentiated impacts within the sectors and the size of enterprises. In terms of sector moderation, the positive impact of DAL on competitiveness is greater in IT/logistics (0.147, $p < 0.001$) and services (0.089, $p = 0.031$) than in manufacturing reference category. In the case of agriculture, there is no significant difference in effect with manufacturing (-0.032, $p = 0.498$). In terms of size moderation, the impact of DAL is β = 0.201 for large enterprises vs. reference ($p < 0.001$), in large enterprises than in small enterprises as the control group. In the case of the medium enterprises, the difference is not considerable.

Table 5 shows individual regressions by each category of the digital tools, controlling for all other tools and covariates. This determines the marginal contribution of each solution.

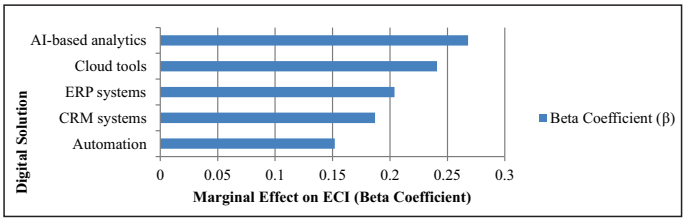
Table 5: Marginal Effects of Individual Digital Solutions on ECI

Digital Solution	β (SE)	p-value	95% CI	VIF
Automation	0.152 (0.034)	<0.001	[0.085, 0.219]	2.14
CRM systems	0.187 (0.031)	<0.001	[0.126, 0.248]	1.98
ERP systems	0.204 (0.036)	<0.001	[0.133, 0.275]	2.33
Cloud tools	0.241 (0.029)	<0.001	[0.184, 0.298]	1.87
AI-based analytics	0.268 (0.042)	<0.001	[0.185, 0.351]	2.56

Note: All models control for firm age, pre-war DAL, donor funding, sector, and size. N = 847. VIF values below 5 indicate no multicollinearity.

It is evident from Table 5 that all five digital solutions contribute positively and significantly to competitiveness. However, AI-based analytics and Cloud tools have the largest marginal effects, followed by ERP, CRM and Automation.

Figure 2: Marginal effects of digital solutions on enterprise competitiveness



Source: Estimates derived from author-conducted survey (N = 847)

Figure 2 shows the marginal impact of each digital solution on the ECI, in descending order of impact. AI-based analytics show the largest marginal effect followed closely by cloud tools. ERP systems, CRM systems, and automation follow in descending order.

Discussion

Interpretation of Findings within Existing Literature

This paper validates that DT can be used to increase the competitiveness of the enterprise in post-war Ukraine (Tyshchenko et al., 2024), which proves the results of stable economies to extreme environmental turbulence. The regression findings can answer RQ1, which proves that the relationship between digital adoption and competitiveness is strong and positive. Moderation analysis answers RQ2, indicating that the effect is more intense in the case of IT/logistics, services, and large enterprises. Subgroup analysis deals with RQ3, and cloud tools along with AI-based analytics are the most influential solutions.

The pre-post analysis shows that there was divergence of 25.9 percentage points in export share: high- DT companies increased all competitiveness indicators between 2021 and 2025, whereas low- DT companies worsened. DT is thereby a protective and enabling factor, which expands to longer-lasting armed conflict the crisis-driven innovation theory (Netz et al., 2022) within a short shock. In contrast to pandemic-era results of reactive, temporary adoption (Lashitew, 2023), wartime DT in Ukraine seems to result in lasting competitive advantages (Stender et al., 2024).

This advantage is explained by five mechanisms. Flexibility - cloud computing allows operations to be quickly moved because it is not tied to any physical location. Resilience AI-driven forecasting ensures the sales volumes even in the case of destruction of the infrastructure, which serves as cognitive infrastructure. Efficiency - the automation and the ERP systems work under stress with mobile power and satellite connection, which is contrary to Sun et al. (2026), who needed an established infrastructure. Resource optimization - CRM systems allow selective use of limited resources (fuel, inventory, labor). The world market is becoming a single global market: cloud-based logistics solutions and artificial intelligence-driven customs automation are breaking down borders, as noted by Gutium (2025). Study outcomes confirm previous findings that digital technologies contribute to operational efficiency: automation reduces operational costs (Shivajee et al., 2019), CRM systems improve customer retention (Lamrhari et al., 2022), and

cloud-based tools enhance scalability (Abu-El-Haija et al., 2025; Karamushka et al., 2018; Sokrovolska et al., 2025).

Theoretical Implications

Three conceptual refinements emerge. In the first place, the dynamic capabilities theory (Teece, 2018) presupposes a sequential development of capabilities; the study notes compressed and parallel sensing-seizing-transforming, suggesting a crisis-accelerated model. Second, while digital maturity models assume linear progression, Dovgal et al. (2021) demonstrate forced non-linear leapfrogging, suggesting that post-conflict contexts require a necessity-based rather than a stage-based model. Unlike stage-based models where firms progress sequentially from basic IT to fully integrated systems, a necessity-based model involves compulsory, parallel adoption across multiple digital solutions without intermediate phases. In our sample, 42% of firms classified as Low DAL in 2021 became High DAL in 2025, bypassing the Medium category entirely. This leapfrogging pattern contradicts linear maturity assumptions and supports a necessity-driven framework for post-conflict settings (Kuryliuk & Kukin, 2022; Mazur et al., 2025). Third, the resource-based perspective (Barney et al., 2025) requires conceptual extension to encompass digital substitute resources, that is, intangible assets that functionally replace destroyed physical resources.

Policy Implications

To policymakers, research suggests making decentralized internet infrastructure a public good, redistributing 15-20% of reconstruction funds to cloud/AI adoption vouchers to SMEs, deploying mobile digital training unit to displaced workers, making IT/logistics/services a priority to digital investment and linking agriculture to rural connectivity, and creating EU digital compliance vouchers. In the case of enterprises, cloud migration and AI analytics are not something to upgrade to but a strategic necessity.

Conclusions

This work empirically shows that DT of business processes is a decisive factor in the competitiveness of enterprises during wartime recovery in Ukraine. The results indicate that high-digital adoption firms showed gains in all competitiveness indicators between 2021 and 2025, whereas low-adoption firms declined, which proves that not only does DT assure against disruption in wartime but also promotes competitive advantages.

Contribution of the Study

Three main contributions emerge. First, DT accelerates competitiveness through five mechanisms: flexibility (cloud-enabled relocation), resilience (AI-driven supply chain adaptation), efficiency (automation under infrastructure duress), resource optimization (CRM-guided prioritization), and global market integration (digital customs and logistics). Second, the competitive advantage of DT is not uniform: it is strongest for IT/logistics and services sectors and for large enterprises, while agriculture shows weaker effects and requires complementary investments. Third, among digital solutions, cloud tools and AI-based analytics deliver the greatest marginal returns in post-war contexts, surpassing automation, CRM, and ERP.

Recommendations

For enterprises, companies must focus on cloud and AI analytics rather than on premise solutions because it is more flexible and predictive in the event of physical infrastructure breakdown. Digital training of the workforce should be accompanied by its adoption in the form of upskilling programs, distance-based certification, and international collaboration. The subsidized cloud subscriptions and shared AI platforms can be used by SMEs as affordable entry-levels. To the policymakers, the rebuilding of Ukraine must include the designation of internet connectivity, which is decentralized, as an essential infrastructure, just like roads and bridges. The donor funding needs to shift 15-20 per cent to digital adoption grants to SMEs. Targeting by sector is a must: focus on IT, logistics, and services to invest in digital now, and adjust agricultural DT with rural connectivity and IoT training. To hasten the process of integration in the EU, create the digital compliance vouchers, e-invoicing, e-customs and data protection. Industry-specific recommendations follow. AI route optimization and cloud warehouse management are beneficial to logistics companies. CRM and cloud collaboration tools are required by the services firms. Manufacturing requires ERP and automation with redundant power and Starlink. The first solution required in agriculture is rural connectivity and IoT infrastructure,

followed by farm management software, and AI forecasting.

Limitations and Future Research Directions

Few limitations should be addressed in future research. The cross-sectional design with retrospective recall may introduce bias; longitudinal tracking of Ukrainian enterprises from 2025 onward is recommended. Self-reported performance data could not be independently verified for all firms; future studies should access tax records or customs declarations. Survivorship bias is present as failed firms are excluded; tracing these enterprises would strengthen causal inference. Generalizability beyond Ukraine requires replication in other post-conflict economies like Ethiopia or Sudan. Also, qualitative case studies are needed to uncover the micro-processes of crisis-driven DT, and natural experiments could help establish causality. Finally, conflict intensity zone can be considered as potential moderator in the considered relationship in future studies.

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