

Design Thinking for Business Process Optimization. Empirical Evidence from Ukrainian Small and Medium-Sized Enterprises in Volatile Markets

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Abstract

The active spread of digital transformation forces small and medium-sized enterprises (SMEs) in Ukraine to look for innovative approaches to improving process efficiency. The aim of the study is to assess the relationship between the level of design thinking implementation, digitalization, innovative activity, and operational efficiency of enterprises.

The methodological framework is a panel-type econometric model with fixed effects based on secondary statistics for 2022–2024. The sample was formed from 252 Ukrainian enterprises representing five sectors of the economy: industry, trade, transport, information and communication technologies (ICTs), and professional services. The business Process Optimization Index (POI) was used as the dependent variable and the Design Thinking Index as the main influencing factor. The obtained results indicate a positive and statistically significant relationship between the implementation of design thinking and the business process efficiency ($\beta=0.215$, $p<0.01$). The highest indicators were recorded in the ICTs (BPO=125.4) and trade (BPO=114.8) sectors, where design thinking is combined with a high level of digital maturity.

The conclusions confirm that the implementation of design thinking is an effective tool for increasing the productivity and competitiveness of small and medium-sized enterprises. The findings also indicate that design thinking contributes to the reduction of transaction costs, optimization of customer acquisition processes, and improvement of customer lifetime value through stronger customer orientation and more efficient business process design. The practical significance is the possibility of applying the obtained results to form state policies to support the innovative development of SMEs. The novelty of the study is the quantitative confirmation of the impact of design thinking on the efficiency of business processes using a composite index and panel econometric analysis.

Keywords: design thinking, business process optimization, digital transformation, innovation management, econometric modelling, operational efficiency, economic resilience.

JEL Classification: M21; L21; O32.

Introduction

The current digital transformation is changing the business environment, forcing SMEs to adapt their processes to remain competitive. Recent studies indicate substantial but uneven levels of digital readiness among SMEs across different regions. Evidence from Indonesia highlights persistent financial, human-resource, operational, and organizational barriers to digital transformation (Anatan & Nur, 2023), while research from Taiwan illustrates how technology adoption can support business adaptation under disruptive market conditions (Chu, 2024). Evidence from Nigeria likewise indicates that the implementation of advanced business-intelligence approaches in SMEs is constrained by organizational and resource-related factors (Lateef & Keikhosrokiani, 2023). However, quantitative evidence on whether and to what extent design thinking directly affects the efficiency of SMEs' business processes in the digital economy remains limited.

Businesses need models that link creative management approaches, digitalization, and operational performance. International studies show the importance of organizational forms, project management and entrepreneurial culture in the transformation of SMEs (Erjavec et al., 2024; Vrečko et al., 2023; Arabeche et al., 2022). Systemic reviews prove that the combination of innovation and digital tools is key for sustainable development (Philbin et al., 2022; Pingilili et al., 2025). Despite this, the academic literature lacks empirical assessments of the impact of design thinking on the business process efficiency. The Ukrainian context is characterized by low digital maturity of some SMEs, which strengthens the relevance of the study. Establishing a quantitative relationship between the integration of design thinking, digital practices, and operational efficiency enables assessing its role in business transformation.

1. Literature Review

In the academic literature, design thinking is increasingly seen as a practical tool for strategic transformation of SMEs, rather than just a creative technique. Demir et al. (2025) show that the use of a structured “toolbox” allows the transformation of informal creative approaches into manageable routine innovation processes suitable for scaling in small

businesses. The authors emphasize that the key is to link design thinking to sustainable growth goals and digital solutions, rather than its isolated application.

Kurek et al. (2023) makes a similar emphasis on the process manageability, considering design thinking as a mechanism for rethinking the business model towards sustainability, but through specific sequential steps, rather than through intuitive design. Both studies indicate that design thinking produces results when it is integrated into the management system, and not used as a one-time facilitation.

Another group of studies focuses on the factors that contribute to the successful application of design thinking in SMEs. Olivares Ugarte & Bengtsson (2024) applied bibliometric analysis to industrial SMEs and identified several critical success factors, including early customer engagement, multidisciplinary teams, and rapid product iteration. These findings are particularly relevant to the Ukrainian context, where many SMEs operate under resource constraints and have limited capacity to sustain lengthy research and development (R&D) cycles. Mesa et al. (2022) show that design thinking can also serve as a tool for “de-risking” the digitalization of manufacturing SMEs, as user-centered prototyping reduces the costs associated with unsuccessful IT implementations. Their findings suggest that digitalization strengthens the contribution of design thinking to organizational change and the development of customer-oriented solutions. In contrast to Olivares Ugarte & Bengtsson (2024), who focus primarily on product innovation, this perspective emphasizes process optimization and operational efficiency, highlighting the importance of process improvements alongside new product development.

An important direction is the combination of design thinking with sustainability, VUCA environment and business model transformation. Niehaus & Mocan (2024) showed in a German case that design thinking helps not only to create innovations, but also to sustain them in changing conditions, when demand and supply chains are unstable. They emphasize the role of internal culture, which is very close to our consideration of fixed effects of sectors. The effect of design thinking is greater when the culture of sustainability or customer orientation is rooted. Ávila-Gutiérrez et al. (2025) made similar conclusions about the need for an operational “framework” by proposing a lean audit as a way to prepare SMEs for digital integration. Their logic is as follows: first we fix current processes, add digital solutions, and then creative approaches. This step-by-step approach, where current processes are first audited and documented, and then digital and creative practices are integrated, is consistent with the authors’ ideas about preparatory measurements before transformation. They emphasize the importance of structured business process analysis as a foundation for effective design thinking implementation.

Recent research highlights complementary roles for design thinking, digital transformation, and business-process optimization in SME adaptation and sustainability. Amirkhizi et al. (2026) examine how design thinking can help startups identify and refine complex ‘wicked problems’ through structured problem exploration. Shmeleva et al. (2026) show the relevance of business-process optimization and digital management tools to operational improvement and sustainability objectives. In the Ukrainian context, Gorokhova and Simanavičienė (2026) examine how digital tools and financing mechanisms can support post-war circular reconstruction and industrial modernization. Taken together, these studies provide complementary, rather than identical, perspectives on the roles of design thinking, digitalisation, and process optimization in organizational adaptation and resilience.

A further direction of research examines the integration of design thinking with marketing, social, and ethical practices. Hartman et al. (2024) demonstrate that design thinking can support segmentation in social networks, particularly when user information is insufficiently structured. This application highlights the adaptability of design thinking to diverse data environments, including those involving unstructured information. Štrukelj and Dankova (2025) further emphasize the role of ethical leadership in SMEs adopting AI-based management practices, particularly in mitigating the risks of biased or subjective decision-making. The integration of design thinking with ethical leadership may therefore facilitate the development of human-centered and stakeholder-sensitive solutions. This perspective is particularly relevant in the Ukrainian context, especially for enterprises involved in public procurement or serving vulnerable consumer groups.

Another path of literature explores design thinking in relation to digital transformation and organizational resilience. Hokmabadi et al. (2024) find that digital transformation can strengthen SME resilience when complemented by marketing capabilities, suggesting that technology alone may be insufficient without appropriate organizational and market-oriented capabilities. This is consistent with the present study's treatment of digitalization (DIG) as a complementary factor in the design-thinking framework. Koldovskiy (2024), from a financial-sector perspective, discusses digitalization as part of broader strategic infrastructure transformation; accordingly, this source is used here as contextual evidence on digital transformation rather than as direct evidence of the effect of design thinking.

Comparing these studies with each other, three important gaps can be identified for our article. First, most studies focus on conceptual or bibliometric reviews and provide almost no quantitative estimates of the effect of design thinking on operational efficiency (Olivares Ugarte & Bengtsson, 2024; Kurek et al., 2023). Second, some authors analyse individual implementation cases but do not take into account differences between sectors, while our approach uses a panel and fixed effects to eliminate industry distortions (Niehaus & Mocan, 2024; Mesa et al., 2022). Third, the literature on the digital integration of SMEs often lacks an index that simultaneously reflects customer orientation, innovation, and cross-functionality, while our study proposes just such a composite indicator of DT. So, the mentioned authors confirm the relevance of design thinking for SMEs, but leave room for empirical, quantitative proof of its impact on business processes, which is what this study does. Despite the existing developments, quantitative studies of the impact of design thinking on the efficiency of SME business processes remain limited. This necessitates further expansion of empirical studies using standardized indicators and comparisons between countries.

2. Materials and Methods

2.1. Research Design and Data

The methodological framework of the study is built on a phased process of quantitative analysis, combining data structuring, variable formation, econometric model construction and interpretation of results. The sequence of stages provides a logical transition from the description of the design thinking phenomenon to its statistical assessment in the context of the efficiency of SME business processes.

The study draws on secondary official statistics, international databases, and open analytical reports, including sources from the State Statistics Service of Ukraine, World Bank, Eurostat, OECD, OECD/European Commission, EBRD, the Ministry of Economy of Ukraine, and Opendatabot. These sources support the construction of the analytical dataset and the descriptive and panel indicators used in the study. The methodological structure is intended to trace the relationship between creative management practices, digitalization, and enterprise performance (Table 1).

Table 1: Assessing the Impact of Design Thinking on SME Business Process Efficiency

Stage	Stage content	Tools	Expected result
Formation of the analytical base	Selection and standardization of secondary data on SME activities for 2022–2024	Eurostat, OECD MSME database, State Statistics Service of Ukraine	A single database of panel indicators by sector
Construction of variables	Calculation of the design thinking index and auxiliary variables (DIG, INNOV, BPO)	Normalization, indexing, standardization (0–1)	A set of explanatory and dependent variables has been formed
Modelling	Construction of a panel model with fixed effects to assess the impact of design thinking	Stata, R (plm package)	β coefficients have been estimated, the significance of relationships has been tested
Interpretation of results	Analysis of the obtained data, comparison of industries, drawing conclusions and providing recommendations	Graphs, diagrams, comparative tables	Regularities and recommendations for SMEs have been identified

Source: developed by the authors.

The proposed procedure covers all key stages of the study from data collection to drawing of practical conclusions. Such a structure ensures the complexity and logical sequence of the analysis. The use of quantitative methods helps to minimize the subjectivity of assessments and to form well-founded conclusions. The approach combines statistical accuracy with the managerial relevance of the results for enterprises in various sectors.

2.2. Sample Selection and Variable Construction

The sample was formed from 252 enterprises covering five main sectors of the Ukrainian economy - industry, trade, transport, ICT, and professional services. Enterprises were selected from seven regions of Ukraine: Kyiv, Lviv, Odesa, Dnipropetrovsk, Kharkiv, Vinnytsia, and Zaporizhzhia. This provides geographical coverage across several major regions but, without a documented probability-sampling design and population weights, should not be interpreted as establishing statistical geographical representativeness. The inclusion criteria were SME status according to the relevant national classification, availability of operational reporting data, participation in digital or innovative processes, and operation for at least three years during the selected period (Table 2). The exclusion criteria were incomplete statistical data, temporary cessation of activities, and liquidation or bankruptcy status.

Table 2: Profile of SMEs included in the Study Sample

Category	Indicator	Number of SMEs	Share (%)
Industry sector	Processing industry	52	20.6
	Wholesale and retail trade	61	24.2
	Transport and logistics	41	16.3
	Information and telecom	48	19.0
	Professional services	50	19.9
Enterprise size	Micro enterprises	96	38.1
	Small enterprises	109	43.3
	Medium enterprises	47	18.6

Category	Indicator	Number of SMEs	Share (%)
Region	Kyiv region	58	23.0
	Lviv region	36	14.3
	Odesa region	34	13.5
	Dnipropetrovsk region	37	14.7
	Kharkiv region	31	12.3
	Vinnytsia region	29	11.5
	Zaporizhzhia region	27	10.7

Source: developed by the authors based on the study sample.

Firm-level data and panel construction. The firm-level panel was constructed using the Financial Results of Enterprises (Annual) dataset of the State Statistics Service of Ukraine, supplemented by firm-level financial information available through Opendatabot and relevant official statistical sources (State Statistics Service of Ukraine, 2026; Opendatabot, 2026). The initial pool of enterprise records was screened according to SME status, sector, geographical coverage, data availability, and continuity of observations during 2022–2024. Enterprises were matched across years using their EDRPOU (Unified State Register) identification code. After applying the selection criteria and excluding observations with incomplete information, 252 enterprises were retained, resulting in a balanced panel of 756 firm-year observations (252 × 3).

The empirical dataset comprises 252 Ukrainian SMEs observed annually during 2022–2024, resulting in 756 firm-year observations. Enterprises were retained when firm-level information was available for all three years and the required variables could be consistently constructed. Firms were matched across years using their unique enterprise identifiers. Observations with missing values for the variables included in the econometric model were excluded. The resulting dataset represents a balanced panel of 252 enterprises × 3 years. All composite indicators were normalized to a 0–1 scale. The variables were constructed from secondary statistical and administrative sources reported in the study (Table 3).

Table 3: Definition and construction of variables

Variable	Measurement / construction
BPO	Revenue / administrative expenses
DT	Composite index of normalized process innovation, customer research, cross-functional collaboration, and intangible-asset investment indicators; equal weights (0.25 each), scaled to 0–1.
DIG	Normalized digitalization indicator (0–1)
INNOV	Share/indicator of innovation-active SMEs
SIZE	Enterprise size based on the SME classification
OPEN	Export openness indicator

Source: developed by the authors

Variable construction. All continuous indicators were converted to a comparable 0–1 scale using min–max normalization:

$$X_{it}^{norm} = \frac{X_{it} - X_{min}}{X_{max} - X_{min}} \quad (1)$$

BPO was calculated as revenue divided by administrative expenses. DT was constructed as a composite index of process innovation, customer research, cross-functional collaboration and intangible-asset investment. DIG, INNOV, SIZE and OPEN were constructed from the corresponding firm-level and official statistical indicators.

The DT Index was calculated as the weighted composite of four normalized components: process innovation, customer research, cross-functional collaboration, and intangible-asset investment. Equal weights (0.25) were assigned to each component. Customer research and cross-functional collaboration were proxied using the corresponding firm-level indicators available in the secondary datasets.

The enterprises were selected by applying the stated eligibility criteria to the identified data sources. The period 2022–2024 was selected to examine enterprise adaptation during wartime disruption, accelerated digitalization, and changing innovation practices. The sectoral coverage allows comparison across activities with different innovation profiles; conclusions are therefore limited to the observed sample, as a probability-sampling design and population weights were not established.

2.3. Econometric Model and Diagnostic Tests

The model is specified as a fixed-effects panel regression. The dependent variable is the BPO index, defined as the ratio of revenue to administrative expenses. The key explanatory variable is the DT index, constructed from normalized indicators of process innovation implementation, customer research, cross-functional interaction, and intangible-asset costs. Control variables include digitalization (DIG), innovation activity (INNOV), enterprise size (SIZE), and openness (OPEN). The estimated coefficient on DT tests the hypothesized positive association between design thinking and process efficiency, conditional on the specified controls and fixed effects.

The basic specification estimates the association between the level of design thinking implementation and business process efficiency in SMEs. The model is presented as a fixed-effects panel regression with sector and year fixed effects, thereby controlling for sector-specific heterogeneity and common time-specific shocks:

$$BPO_{it} = \alpha + \beta_1 DT_{it} + \beta_2 DIG_{it} + \beta_3 INNOV_{it} + \beta_4 SIZE_{it} + \beta_5 OPEN_{it} + \gamma_i + \delta_t + \varepsilon_{it} \quad (2)$$

where: BPO_{it} – business process optimization index; α – constant; DT_{it} – design thinking index based on process innovation, customer research, cross-functional interaction, and intangible assets; DIG_{it} – enterprise digitalization level; $INNOV_{it}$ – innovation activity; $SIZE_{it}$ – enterprise size; $OPEN_{it}$ – export openness; γ_i – sector fixed effects; δ_t – time fixed effects capturing 2022–2024 shocks; ε_{it} – random error.

The preferred specification includes sector and year fixed effects. Robust standard errors are used to account for heteroscedasticity. Model specification was assessed using the Hausman test, while residual dependence and multicollinearity were examined using the Durbin–Watson/Wooldridge and VIF diagnostics, respectively.

The coefficients of the explanatory variables are interpreted in accordance with the study hypotheses. A positive β_1 indicates that greater adoption of design thinking is associated with improved business process optimization, whereas a positive β_2 reflects the contribution of enterprise digitalization to process efficiency. The coefficient β_3 captures the effect of innovation activity and is expected to be positive. The effect of enterprise size β_4 may vary depending on economies of scale and organizational complexity, while a positive β_5 indicates that greater exposure to external markets is associated with improved operational efficiency and adoption of new managerial practices.

Model adequacy was assessed through the diagnostic procedures reported for the final specification. The Hausman test was used as part of model-specification assessment. Heteroscedasticity and serial correlation were examined using the reported heteroscedasticity and Durbin–Watson/Wooldridge diagnostics, respectively, while multicollinearity was evaluated using variance inflation factors (VIF). Robust standard errors were used in the final model.

Accordingly, the empirical framework evaluates the hypothesized positive association between design thinking and business process optimization while controlling for digitalization, innovation activity, enterprise size, market openness, sector-specific heterogeneity, and time-specific shocks. The final model includes sector and year fixed effects only. Enterprise-level fixed effects were not included. Robust standard errors were used. The Hausman test, heteroscedasticity test, serial-correlation test and VIF were applied to assess model specification and diagnostics.

The empirical analysis was conducted using R, primarily through the *plm*, *lmtest*, and *car* packages, and Stata using panel-data estimation procedures. These tools were employed for panel regression estimation and diagnostic testing for heteroscedasticity, serial correlation, and multicollinearity. Graphical analyses were additionally used to examine temporal changes in the DT, DIG, and BPO indices and to illustrate sectoral heterogeneity. Together, these procedures provide a systematic framework for model estimation, diagnostic assessment, robustness testing, and interpretation of the empirical results.

3. Research Results

Table 4 reports a positive coefficient for the Design Thinking Index (DT) ($\beta = 0.215$, $t = 3.42$, $p = 0.001$). Under the level-level specification currently written in Equation (2), a 0.1-point increase in DT corresponds to a 0.0215-unit increase in BPO, not a 2.1% increase. A percentage interpretation would require a logarithmic or explicitly percentage-scaled dependent variable, which is not documented in the current variable definition. DIG is also positive ($\beta = 0.164$, $p = 0.004$), INNOV is positive ($\beta = 0.142$, $p = 0.024$), OPEN is positive ($\beta = 0.097$, $p = 0.041$), while SIZE is positive but not statistically significant at the 5% level ($\beta = 0.053$, $p = 0.087$). These coefficients should be described as conditional associations unless the identification strategy supports a causal interpretation. The reported within R^2 is 0.47.

Table 4: Panel Model Results for Design Thinking and SME Business Process Optimization ('22–'24)

Variable	Designation	Expected Sign	Coefficient β	t-statistic	Value p	Interpretation
Design Thinking Index	DT	+	0.215	3.42	0.001	Under the stated level-level model, a 0.1 increase in DT corresponds to a 0.0215-unit increase in BPO; a percentage interpretation requires additional scaling or transformation.
Level of SME Digitalization	DIG	+	0.164	2.87	0.004	Higher DIG is positively associated with BPO, conditional on the stated controls.
Company Size	SIZE	$\pm$	0.053	1.71	0.087	Positive coefficient, but not statistically significant at the 5% level ($p = 0.087$); substantive interpretation depends on the exact SIZE coding.
Innovative Activity	INNOV	+	0.142	2.29	0.024	Higher INNOV is positively associated with BPO, conditional on the stated controls.
Openness/Export Orientation	OPEN	+	0.097	2.05	0.041	Higher OPEN is positively associated with BPO, conditional on the stated controls.
Fixed Effects	γ_i, δ_t	—	Yes	—	—	Sector and year fixed effects included; enterprise fixed effects not included.

Note: N = 756 (252 enterprises × 3 years); within $R^2 = 0.47$; $F = 12.63$ ($p < 0.001$); Hausman $\chi^2 = 19.8$ ($p = 0.002$); DW = 1.96; VIF < 3. The model includes sector and year fixed effects and robust standard errors; * *Sector fixed effects: Yes; Year fixed effects: Yes; Enterprise fixed effects: No*

Analysis of the sector-level values in Table 5 shows uneven changes in the reported indices. In 2024, the highest DT values are reported for ICT (0.71) and trade (0.58), followed by professional services (0.57), processing industry (0.47), and transport (0.44). Based on the five sector values shown in Table 5, mean BPO increases from approximately 102.2 in 2022 to 110.5 in 2024. Over the same period, BPO increases by approximately 8.9% in ICT (115.2 to 125.4), 10.7% in trade (103.7 to 114.8), 7.2% in processing industry (94.5 to 101.3), 6.8% in transport (91.4 to 97.6), and 6.5% in professional services (106.3 to 113.2). These are descriptive sector-level changes and should not, by themselves, be interpreted as causal effects of design thinking.

The descriptive sectoral pattern shows higher DT and BPO values in ICT and trade than in processing industry and transport. Sectoral differences may be consistent with differences in customer interaction, digital intensity, investment requirements, and organizational flexibility, but these mechanisms are interpreted as possible explanations rather than effects established by the descriptive evidence.

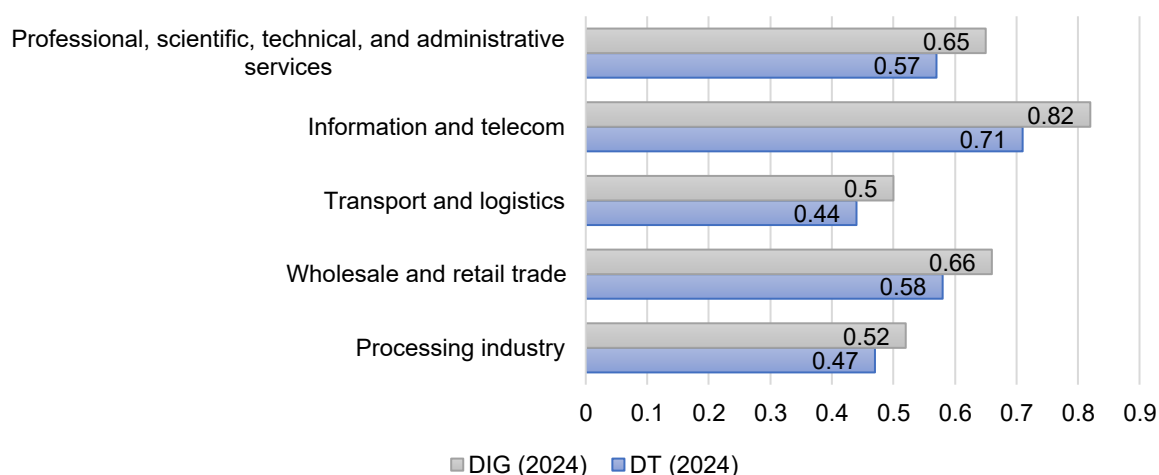
Table 5: Panel Data for Comparative Analysis of SMEs by Sector, 2022–2024

Sector	Year	DT	DIG	INNOV, %	BPO
Processing industry	2022	0.38	0.42	21	94.5
	2023	0.42	0.47	23	97.2
	2024	0.47	0.52	25	101.3
Wholesale and retail trade	2022	0.46	0.55	27	103.7
	2023	0.52	0.60	30	108.9
	2024	0.58	0.66	32	114.8
Transport and logistics	2022	0.34	0.40	19	91.4
	2023	0.39	0.45	21	94.1
	2024	0.44	0.50	23	97.6
Information and telecom	2022	0.61	0.72	38	115.2
	2023	0.66	0.77	41	119.7
	2024	0.71	0.82	44	125.4
Professional, scientific, technical, and administrative services	2022	0.49	0.57	29	106.3
	2023	0.53	0.61	31	109.5
	2024	0.57	0.65	33	113.2

Note: DT – design thinking index (0–1); DIG – digitalization index (0–1); INNOV – share of innovation-active SMEs (%); BPO – business process optimization index (higher values indicate better performance).

Source: Authors' calculations based on data from the State Statistics Service of Ukraine (2024), World Bank (2024), OECD (2023), Eurostat (2024), Ministry of Economy of Ukraine (2023), EBRD (2023), and OECD & European Commission (2023).

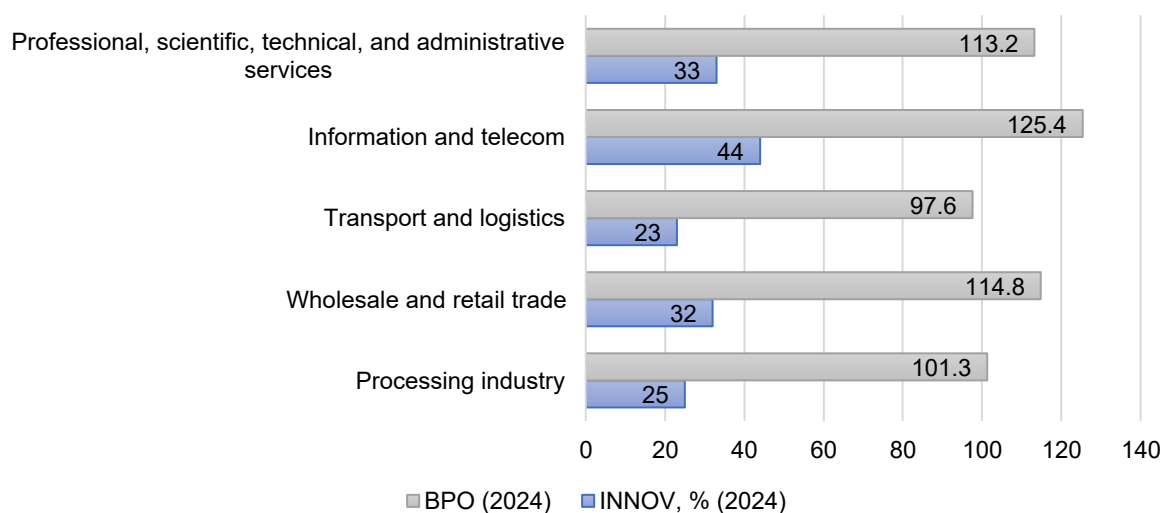
Figure 1: Average values of DIG and DT for 2024



Source: Authors' calculations based on data from the State Statistics Service of Ukraine (2024), World Bank (2024), OECD (2023), Eurostat (2024), Ministry of Economy of Ukraine (2023), EBRD (2023), and OECD & European Commission (2023).

The BPO values reported in Table 5 increase in all five sectors between 2022 and 2024. In 2024, the highest reported values are ICT (125.4) and trade (114.8), followed by professional services (113.2), processing industry (101.3), and transport (97.6). Across the five sector averages shown in Table 5, mean BPO rises from approximately 102.2 in 2022 to 110.5 in 2024, an increase of about 8.2 index points over the two-year interval (approximately 4.1 points per year on a simple average basis). These changes are descriptive and should not be interpreted as evidence of a causal effect of design thinking.

Figure 2: Average Values of BPO and INNOV for 2024



The 2024 values in Table 5 show that ICT and trade combine relatively high DT, DIG, and BPO values. These descriptive patterns are consistent with a positive association among the reported indicators, but they do not establish why the sectoral differences occur or identify causal mechanisms.

In summary, the reported panel results are consistent with a positive conditional association between DT and BPO after inclusion of the stated controls, sector fixed effects,

and year fixed effects. Given the observational design, the results are interpreted as associations rather than systemic causal effects at the firm or regional level.

The results indicate a positive association between the reported DT index and SME business process optimization in the estimated panel specification. This is consistent with García-Vidal et al. (2025), who discuss growing SME interest in data-driven approaches to business processes and the need for implementable tools. The present study extends this literature by examining the relationship quantitatively in a panel of Ukrainian SMEs during 2022–2024.

Omidvar et al. (2025)'s findings that business model innovation is the link between CSR and SME success in the digital era confirm our result on the synergy of design thinking and digitalization. The authors argue that a company only achieves sustainable results when innovation is rooted in a value proposition, not in a single technology. In our case, this is evident from the simultaneous significance of the DT and DIG variables. If digitalization is present without design thinking, then efficiency gains are weaker. If design thinking is applied without digital tools, scalability is limited. So, our study stands between these two approaches and confirms that SMEs need a double transformation.

Mikelsone and Cīrule (2024) demonstrate that design thinking works effectively as a method for creating impact assessment tools when it is necessary to connect stakeholders and urban policies. Our approach is similar in logic, as it also uses a composite indicator, but we applied it to business processes, not urban development. Bierwisch et al. (2021) proved that design-oriented workshops facilitate the development of eco-innovative business models while reducing staff resistance. This is consistent with our observation of a higher effect in service sectors, where it is easier to involve employees in co-design. At the same time, their study relies more on facilitation formats, while ours tries to show a quantitative, econometrically confirmed effect.

The model for selecting an innovation strategy for industrial enterprises proposed by Mironova et al. (2022) emphasizes the formalization of criteria in strategic decision-making. Our results are partly different, as we recorded a positive, albeit smaller, effect of design thinking specifically in industry. This suggests that design thinking may contribute to mitigating innovation-related risks in sectors with high capital intensity. Prokopenko et al. (2024) examine the development of blockchain technology in financial accounting, illustrating the broader relevance of digital technologies to the transformation of organizational processes. In the present study, this broader digital-transformation perspective complements, but does not directly validate, the design thinking index.

The works of Sumets et al. (2022), as well as the studies of Voronina et al. (2024) confirm another important thesis that has something in common with our findings: sustainable results appear when management innovations are combined with environmental and social dimensions. We saw a similar effect in service sectors, where customer orientation and social responsibility directly affect service processes. The strategies of sustainable development of the enterprise described by Orlov et al. (2020) show that strategic success should be supported by information support and transparent KPIs. In our model, such a KPI becomes the BPO indicator. A similar position is taken by Dumanska et al. (2021), emphasizing the role of information support in the evaluation of investment projects. This once again confirms that the econometric approach to design thinking is justified, because it gives managers a measurable result.

In addition to the psychological and methodological aspects, design thinking also proves to be economically beneficial to SMEs, as it leads to the minimization of operating inefficiencies, transaction costs and acquisition costs. The findings reveal that firms with greater DT indicators also exhibit higher BPO performance, particularly in firms that are more customer-oriented (ICT and trade). This implies that design thinking is not just about flexibility in the process but also about quantifiable financial efficiency.

In the context of Lean management principles, Design Thinking can minimize various types of organizational waste such as unnecessary iterations in the process, an ineffective product feature, delays in communication between employees or departments, or unprofitable administrative work. Involving customers early, prototyping quickly, and testing numerous times reduces the risk of implementing unsuccessful business solutions, thereby reducing the expense of rework and failed innovation projects. The discovery aligns with the Lean systems idea of “waste minimization”, which looks at how to use resources better and make the processes more productive as the system is designed to meet the customer's needs.

One of the significant economic tools of DT is transaction cost reduction. Information asymmetry, coordination inefficiencies, and extra costs of collecting customer feedback are common issues that can affect SMEs in uncertain and very dynamic markets. These challenges are overcome by the continuous interaction with users, cross functional collaboration, and data driven decision making that are at the heart of design thinking. This, in turn, reduces businesses' expenditure on rectifying market misalignments and suboptimal management choices. In this context, DT is a coordination mechanism that will enhance the information flow between departments and customers.

In particular, in the marketing and customer relationship management field, the impact of design thinking is clearly visible. By leveraging the principles of customer empathy and co-creation, SMEs can better understand consumers' needs and lower Customer Acquisition Costs (CAC). More accurate targeting and tailoring of products and services boosts conversions and saves on wasteful expenditures on poor sales campaigns. Meanwhile, improved customer satisfaction and personalization lead to improved customer retention rates, and higher Customer Lifetime Value (LTV). Thus, the design thinking process can be used to build revenue streams which are not just operational improvements.

These mechanisms are consistent with the empirical patterns reported in the study. Digital practices and quick feedback cycles are more strongly represented in the customer-oriented ICT and trade sectors, which also show comparatively high BPO values. The positive coefficients for DT ($\beta = 0.215$) and DIG ($\beta = 0.164$) indicate positive conditional associations with BPO. Accordingly, design thinking may be viewed not only as a creative method but also as a managerial approach that can support process improvement, particularly when combined with digital tools such as CRM systems, analytics, and process automation.

Overall, the analysed literature supports examining design thinking within the digital, innovative, and sustainability-related development of SMEs. The reported panel estimates indicate positive conditional associations between DT, DIG, INNOV, OPEN, and BPO. Given the observational design and the final specification based on sector and year fixed effects, these estimates are interpreted as associations rather than causal effects.

The practical use of the results is the possibility of implementing design thinking as a tool for operational optimization at the level of individual business processes. Enterprises can use the obtained indicators to prioritize innovations, form cross-functional teams and reduce costs for inefficient processes. The results can also support management decisions on investing in

digital tools that enhance creative practices. Industrial and business associations can use the findings to develop training programmes and support SMEs in transformational conditions. Further research requires a deeper micro-level analysis using primary surveys and qualitative methods to increase the accuracy of the results.

Digital transformation and competitive pressure increase the relevance of creative management approaches for SMEs. In the reported panel specification with sector and year fixed effects, DT is positively associated with BPO ($\beta = 0.215$, $p = 0.001$), while DIG, INNOV, and OPEN also have positive reported coefficients. Under the level-level specification, a 0.1-point increase in DT corresponds to a 0.0215-unit change in BPO. Sector-level descriptive values show the highest 2024 DT values in ICT (0.71) and trade (0.58). These findings are interpreted as conditional associations rather than causal effects.

The reported sector-level patterns are consistent with greater DT, DIG, and BPO values in customer-oriented sectors, but the current evidence does not directly identify reductions in transaction costs, customer-acquisition costs, or other specific mechanisms. Such mechanisms should be presented as plausible managerial interpretations unless they are measured directly in the dataset.

In summary, the study proposes a quantitative panel framework for examining the association between design thinking and SME business-process performance. The findings provide an empirical basis for considering design thinking alongside digitalization, innovation activity, enterprise size, and market openness in SME process analysis. Further research using transparent firm-level data and primary organizational measures would strengthen the assessment of design thinking practices and their economic consequences.

CRediT Authorship Contribution Statement

Bulavina, O.: Conceptualization, Methodology, Supervision, Writing – original draft, Writing – review & editing. Rudyk, O.: Methodology, Data curation, Formal analysis, Validation. Chasovnykov, D.: Investigation, Formal analysis, Visualization. Mynchynska, I.: Data curation, Validation, Writing – review & editing. Lytvynenko, A.: Investigation, Literature review, Visualization, Writing – review & editing. All authors reviewed and approved the final version of the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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Conflict of Interest Statement

The authors declare no conflicts of interest related to this study.

Data Availability Statement

The study is based on secondary data obtained from publicly available official statistical databases and reports cited in the manuscript. The data sources used for the analysis are identified in the Methods section and References.

Ethical Approval Statement

Ethical approval was not required for this study, as the research was based exclusively on secondary, publicly available, and aggregated data and did not involve human participants, personal data, or experimental interventions.

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