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From software to strategy: How process performance unlocks business value in the logistics industry

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Abstract

Aim/purpose – This study investigates how process performance mediates the relationship between software performance and business performance in Türkiye's logistics industry. It addresses the problem of fragmented digitalization efforts that fail to integrate software with strategic process improvements.

Design/methodology/approach – The research employs a quantitative approach, using survey data collected from 124 managers in micro-, small-, medium-, and large-scale Turkish logistics businesses that utilize Transportation Management Systems (TMS). Data analysis is conducted via SPSS 28 and PROCESS Macro (Model 4) to test mediation effects.

Findings – The results confirm a dual-channel mechanism in which software performance exerts a direct effect on business performance and a stronger indirect effect mediated by strategic process performance. Specifically, TMS software enhances alignment, speed, and quality in strategic decision-making, which, in turn, drives superior outcomes across competitive metrics such as customer satisfaction, cost reduction, market share, and profitability.

Research implications/limitations – The findings highlight the need for process-centric strategies in software adoption; therefore, the study focuses on strategic decision-making performance rather than operational metrics. In addition, the results are limited to the logistics industry in Türkiye and rely on self-reported data.

Originality/value/contribution – This study extends digital value-realization research by quantifying the mediating role of process performance in the relationship between TMS software performance and business performance in Türkiye's logistics industry. By

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integrating the resource-based view and business process management, it shows that software capabilities contribute to business outcomes both directly and – more strongly – through process-based conversion mechanisms in an emerging-economy context.

Keywords: Software performance, process performance, business performance, logistics industry, emerging economies, mediation analysis.
JEL Classification: L91, M15, O32.

1. Introduction

In recent years, profound transformations in competitive strategies and operational paradigms across various industries have been catalyzed by technological advancements and pervasive digitalization. Cutting-edge technologies – including artificial intelligence (AI), big data analytics, machine learning (ML), and cloud computing – are no longer regarded as mere facilitators of automation but are positioned as strategic enablers that redefine how business processes are designed, executed, and optimized (Davenport & Ronanki, 2018; Wamba-Taguimdje et al., 2020). In an era marked by hypercompetition, volatile market dynamics, and escalating customer expectations, aligning process efficiency with strategic agility is recognized as a critical determinant of business survival (Helfat & Raubitschek, 2018). Digitalization is thus framed as a dual-force driver: operational costs and error rates are reduced, while decision-making velocity and customer experience are enhanced (van der Aalst et al., 2016; Verhoef et al., 2021).

The role of technology in process performance transcends basic automation. Holistic process governance, real-time performance monitoring, and data-driven continuous improvement are enabled by process-centric software solutions – such as Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), and Business Process Management (BPM) systems (Dumas et al., 2018; Trkman et al., 2016). Operational transparency is fostered and alignment with strategic objectives is ensured through these systems, which enable quantification of process performance through digitized workflows, thereby institutionalizing iterative improvement cycles (Kettinger et al., 2021). Within process management scholarship, performance metrics are increasingly acknowledged as barometers of strategic success rather than mere operational outputs. Multidimensional frameworks that integrate cost efficiency, quality, customer satisfaction, and workforce productivity are replacing traditional systems, underscoring process management as a source of operational resilience (Hammer, 2015).

The scope of process-oriented management is further expanded by digital transformation, including innovations such as AI-driven analytics, robotic process automation (RPA), and Internet of Things (IoT)-enabled workflows (Vial, 2019). Predictive insights derived from process data enable proactive adjustments to strategy (Grover et al., 2018), repositioning process management as a strategic asset for enterprise-wide value creation (Legner et al., 2017). This transformative potential is exemplified by the logistics industry, particularly in emerging economies where infrastructural inefficiencies persist. Core logistics functions – including route optimization and dynamic fleet management – are revolutionized by Transportation Management Systems (TMS) that leverage geospatial analytics and IoT (Gupta et al., 2022; Wang et al., 2019). Fuel costs are reduced, and customer satisfaction is elevated through the granular visibility enabled by TMS automation facilitating continuous refinement aligned with established process maturity models (Rosemann & de Bruin, 2005).

The integration of the Resource-Based View (RBV) and BPM perspectives provides a coherent explanation of how technological resources, such as TMS software, are converted into performance through organizational capabilities (Barney, 1991). This gap is especially salient in Türkiye. While digitalization efforts have increased, industry reports and empirical observations indicate that adoption remains uneven due to costs, limited technical expertise, and resistance to change (Turkish Statistical Institute, 2023). Many businesses implement TMS in a fragmented manner, making Türkiye a suitable setting to examine how selective digitalization impacts process efficiency and business performance in resource-constrained environments. Consequently, this study examines the impact of TMS software on business performance within the Turkish logistics industry – encompassing micro-, small-, medium-, and large-scale businesses – using process performance as a mediating mechanism.

The remainder of this paper is organized as follows: Section 2 reviews the literature and develops the hypotheses; Section 3 describes the methodology; Section 4 presents the results; and Section 5 discusses the implications and concludes the study.

2. Literature review

Increasing global competition, rapidly changing customer expectations, and digital transformation compel businesses to continuously review and restructure their processes to remain competitive (Davenport, 1993). Business processes, defined as systematic and repeatable structures that convert inputs into outputs, form the foundation of organizational performance (Davenport, 1993; Zairi, 1997). Accordingly, effective process management is a key determinant of business success (Rummler & Brache, 1995). Recent studies have increasingly examined the influence of software and information technologies (IT) on BPM, exploring how digitally supported process management practices affect business outcomes (Dumas et al., 2018; Kerpedzhiev et al., 2021).

Initially conceptualized as an IT-centered concept (Smith & Fingar, 2003), BPM has evolved into an integrated managerial framework that enables the design, implementation, monitoring, and optimization of processes (Weske, 2012). Beyond operational efficiency, BPM aims to align process improvements with broader strategic goals (Lee & Dale, 1998) and to enhance organizational agility through customer orientation, cross-functional integration, and employee participation (DeToro & McCabe, 1997). This evolution demonstrates a shift from viewing BPM as a technical tool toward recognizing it as a holistic capability for organizational transformation.

Nevertheless, the extent to which information technologies are integrated into BPM phases remains a crucial element for performance outcomes. For example, Siriram (2012) emphasized the dual "human-technology" aspect, proposing that software-supported processes boost business performance when technological capabilities align with managerial skills. Empirical evidence supports this by showing that software-enabled BPM applications enhance process flexibility, decision quality, and operational efficiency (Lee et al., 2011; Tallon, 2008). These findings collectively suggest that software adoption not only drives process automation but also enables strategic changes in decision-making structures.

However, the literature still tends to evaluate BPM effectiveness through isolated perspectives. Özan (2021) highlighted that the maturity of process management – encompassing design, measurement, improvement, and control – is crucial to shaping business results. This indicates that assessing software's impact involves not only considering software quality but also the institutionalization of ongoing improvement capabilities (Kettinger et al., 2021). Especially in complex industries such as logistics, where multiple processes interact dynamically, analyzing the contribution of software to each process area separately has been identified as an important yet underexplored need (Wang et al., 2016; Wang et al., 2019).

Despite these insights, a critical review of the literature (dos Santos Rocha & Fantinato, 2013) revealed a persistent methodological gap. Most software-based BPM research has concentrated on the initial "design" and "configuration" phases, leaving the "enactment" and "evaluation" stages, where actual process performance and feedback occur, largely uninvestigated. Consequently, the impact of software on performance through BPM has been examined in a partial rather than holistic manner. Addressing this imbalance remains a key research need, particularly for industries such as logistics, where the realization of software value depends on process execution and evaluation mechanisms (Rosemann

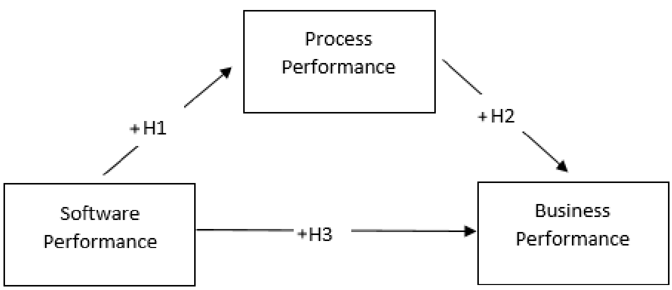
& vom Brocke, 2015). Accordingly, this study aims to fill this gap by empirically examining how software performance translates into business outcomes through process performance within the logistics industry, offering a more integrated understanding of digital value creation in an emerging economy context.

3. Research model and hypotheses

The primary objective of this study is to investigate the mediating role of process performance in the relationship between software performance and business performance within the logistics industry of an emerging economy. Grounded in the resource-based view (Barney, 1991) and process management literature (Dumas et al., 2018; Rosemann & vom Brocke, 2015), the research conceptualizes software performance as the independent variable (X), process performance as the mediating variable (M), and business performance as the dependent variable (Y). This triadic framework is built on prior studies that posit that software enables operational excellence (Lee et al., 2011) and that process maturity serves as a conduit for strategic value creation (Kettinger et al., 2021; Trkman, 2010).

The hypothesized model (Figure 1) asserts that software performance exerts both direct effects on business performance (e.g., through cost reduction or scalability) and indirect effects mediated by process performance (e.g., enhanced process agility and reduced cycle times). This dual pathway approach aligns with Tallon's (2008) IT business value framework, which emphasizes the interplay between technological capabilities and processual efficiency in driving competitive outcomes. Specifically, in the logistics context where software solutions such as TMS and AI-driven analytics are pivotal, process performance acts as a critical bridge, translating technical functionality (e.g., real-time route optimization) into measurable business gains (e.g., delivery reliability, customer retention) (Wang et al., 2016; Wang et al., 20219).

Figure 1. Proposed research model



Source: Authors's own elaboration.

By testing this mediation model using regression based mediation analysis on survey data from Türkiye's logistics businesses, the study addresses a gap in the literature: while prior research has examined software's direct impact on business outcomes or process performance in isolation (Röglinger et al., 2012), few studies holistically evaluate the interdependencies between these constructs in the logistics industry from an emerging economy. The findings aim to advance a theoretical understanding of digital value creation and to provide actionable insights for logistics businesses seeking to align software investments with process-driven strategic priorities.

This study positions process performance as a theoretically grounded and practically consequential mediating mechanism that explains how software capabilities are transformed into business value. From a theoretical perspective, process performance captures the organizational routines and coordination mechanisms through which technological resources are operationalized, thereby linking digital capability with business-level outcomes. From a practical standpoint, it demonstrates that technology-driven performance gains materialize only when digital tools are embedded within structured, transparent, and continuously improved processes. In this regard, process performance is the essential driver that translates software functionality into strategic, measurable business results.

Within this framework, the following hypotheses are tested:

H1: Software performance has a positive and significant effect on process performance.

H2: Process performance has a positive and significant effect on business performance.

H3: Software performance has a direct positive and significant effect on business performance.

H4: Process performance mediates the relationship between software performance and business performance.

3.1. Research population and sample

The study sample comprises a comprehensive range of logistics businesses in Türkiye, including micro-, small-, medium-, and large-scale firms operating in Türkiye, a representative emerging economy characterized by rapid digitalization in supply chain ecosystems. Data were collected using convenient sampling, a pragmatic approach for exploratory research in contexts where access to specialized businesses is limited (Saunders et al., 2019).

A structured survey (with voluntary participation, ensuring confidentiality and adherence to ethical guidelines) was administered to middle and senior managers in logistics, operations management, and information systems departments, as well as to key stakeholders responsible for process execution and technology adoption (Kettinger et al., 2021). These respondents were selected for their operational expertise and decision-making authority, ensuring the reliability of insights into software performance linkages (Tallon, 2008).

While 124 valid responses were obtained, the exact number of distinct logistics businesses represented in the sample could not be definitively determined due to the anonymized nature of the data collection process. Although participants were sampled from different logistics businesses actively using TMS software, multiple responses may have been collected from the same business. The data were collected through an industry-wide employee survey distributed across various logistics businesses in Türkiye. Given that the constructs examined reflected individual-level perceptions and experiences, the analysis naturally focused on employees' reported responses. This design enabled the study to capture a broad range of organizational contexts without centering the comparison on businesses. As the unit of analysis was the individual manager, this study focused on managerial perceptions, recognizing the potential for intra-organizational variation. This limitation has been acknowledged as a trade-off between preserving respondent anonymity and mapping organizational uniqueness.

The sample primarily consisted of middle and senior managers, selected based on their decision-making authority and operational knowledge of software use and process implementation. While the actual managerial hierarchy within each business was not benchmarked against the sample distribution, this respondent profile was intentionally targeted to ensure informed perspectives on the strategic and processual dimensions of TMS software. Thus, the study prioritized managerial insight over hierarchical proportionality, a sampling limitation that was acknowledged.

The descriptive statistics indicated that a plurality of participants (49.2%) worked in medium-sized businesses, while the majority (54.8%) were employed in those with an annual financial balance exceeding 100 million TL (Table 1). Participants were predominantly distributed across the 26-35 (35.7%) and 36-45 (30.2%) age groups. Educationally, most held at least a bachelor's degree (62.7%), with 18.3% having completed postgraduate studies. Professionally, a significant proportion of participants had extensive experience: 42.1% report over 12 years of industry-specific experience, and 40.5% had more than 12 years of general professional experience. Overall, the sample comprised experienced professionals employed in medium- and large-scale businesses.

Table 1. Demographic and organizational profile of the respondents

Variable	Categories	Frequency	Percentage (%)
Business size	micro	11	8.7
	small	15	11.9
	medium	62	49.2
	large	17	13.5
	very large	21	16.7
Annual financial balance	< 10 million tl	15	11.9
	10–100 million tl	27	21.4
	100–500 million tl	36	28.6
	> 500 million tl	33	26.2
Age	18–25	22	17.5
	26–35	45	35.7
	36–45	38	30.2
	46–55	20	15.9
	56+	1	0.8
Education level	associate	24	19.0
	bachelor	79	62.7
	master	21	16.7
	doctorate	2	1.6
Industrial experience	< 3 years	24	19.0
	3–6 years	23	18.3
	6–9 years	14	11.1
	9–12 years	12	9.5
	>12 years	53	42.1
Professional experience	< 3 years	22	17.5
	3–6 years	25	19.8
	6–9 years	15	11.9
	9–12 years	13	10.3
	>12 years	51	40.5

Source: Authors' own elaboration.

3.2. Measurement instruments and variables

The measurement scales employed in this study were adapted from established literature and rigorously translated into Turkish using Brislin's (1986) back-translation protocol to ensure linguistic and conceptual equivalence (Behr, 2017). Each construct was operationalized as a multidimensional conceptual structure and measured using a five-point Likert scale (1 = strongly disagree, 5 = strongly agree), a widely validated approach for capturing perceptual data in management research (Hair et al., 2019).

In this study, software performance referred to the perceived effectiveness, service quality, technological competence, functionality, vendor performance, and cost efficiency of TMS software in supporting logistics operations. It captures how well digital tools facilitate planning, monitoring, and coordination tasks, as employees experience. In contrast, the process performance referred to the effectiveness of managerial and strategic decision-making processes that support logistics operations (e.g., planning quality, decision speed, and decision coherence). It was operationalized using items drawn from the strategic decision-making literature; therefore, it did not directly capture purely operational workflow metrics. While software performance related to the technological capabilities provided by the system, process performance concerned how these capabilities were embedded in day-to-day operational routines and translated into tangible organizational outcomes.

Software performance: This construct was assessed through 16 items reflecting five dimensions: service quality, technological competence, functionality, vendor performance, and cost efficiency (Doğaner Duman & Altuntaş, 2024).

Process performance: This construct was measured using eight items adapted from the strategic decision-making literature, capturing how organizational structures, information systems, and strategic processes influence decision quality and coherence (Aydıner, 2016; Bayraktar et al., 2009).

Business performance: This construct was measured using 12 items adapted from prior empirical studies (Yamin, 1999; Vickery et al., 1993; Wilcox King & Zeithaml, 2001). It captured perceived organizational performance relative to competitors across financial, operational, and customer-related dimensions[1].

It should be noted that software performance is more appropriately conceptualized as a formative construct rather than a reflective one in the model (Bollen & Lennox, 1991; Coltman et al., 2008). In any formative model, the dimensions define the construct. A change in any dimension alters the overall construct score. The dimensions are not necessarily highly correlated, and omitting a dimension alters the construct's meaning. In this study, a logistics business's overall software performance is determined by its performance across these five dimensions. A TMS can, for instance, have excellent functionality (e.g., advanced route optimization) but poor vendor support. These dimensions are not interchangeable indicators of a single underlying trait; instead, all are combined to form the overall assessment of "software performance." Therefore, creating a composite score that aggregates these formative indicators is a theoretically

[1] Detailed information about the criteria is provided in Appendix.

sound and widely accepted practice in management and IS research (Hair et al., 2019; Petter et al., 2007).

For each construct – software performance, process performance, and business performance – the composite score was calculated by summing the item scores within each scale. This summation method was chosen to reflect the cumulative influence of all dimensions and preserve scale sensitivity, especially considering the multidimensional structure of the constructs. While Likert-type items are ordinal, summated scale scores are widely accepted in the social sciences and are supported by the psychometric literature when internal consistency is high, and the data distribution is approximately normal (Carifio & Perla, 2008; DeVellis, 2016; Hair et al., 2019; Norman, 2010). As reported in Tables 2 and 3, the reliability coefficients exceeded the accepted thresholds, and the skewness and kurtosis values fell within acceptable ranges. Therefore, the use of summated scores was deemed appropriate for subsequent parametric analyses, including correlation and mediation modeling.

3.3. Validity and reliability

Starting with the test of normality, skewness, and kurtosis values were used as benchmarks. The fact that these values for the scales stayed within ±1.5 (Tabachnick & Fidell, 2013) and ±2.0 (George & Mallery, 2010) indicated that the data were normally distributed. Given that both skewness and kurtosis coefficients for the model's dimensions ranged between (–1.439 and –0.941) and (1.174 and 1.503), respectively, which were below acceptable thresholds, parametric tests could be appropriately applied to the subsequent analyses of these dimensions.

The dataset's suitability for factor analysis was assessed using the Kaiser–Meyer–Olkin (KMO) Test and Bartlett's Test of Sphericity. KMO values above 0.50 and statistically significant Bartlett's Test results ($p < 0.01$) are required for adequacy (Altuntaş et al., 2020). As presented in Table 2, all scales demonstrated superb sampling adequacy (KMO > 0.90), and Bartlett's Test confirmed significant intercorrelations ($p < 0.01$), validating the dataset's suitability for factor analysis.

Table 2. KMO and Bartlett's test results

Variable	KMO Value	Chi-Square	Bartlett's Test (p)
Software performance	0.924	1218.94	< 0.01
Process performance	0.903	1138.49	< 0.01
Business performance	0.934	1285.57	< 0.01

Source: Authors' own elaboration.

The exploratory factor analysis yielded a tripartite latent construct configuration, as presented in Table 3. The primary factor comprised indicators aligned with software performance; the secondary factor aggregated metrics reflective of process performance; and the tertiary factor encapsulated variables constitutive of business performance. A substantial proportion of standardized factor loadings ($\lambda \geq 0.50$) exceeded conventional psychometric thresholds, indicating robust item-construct congruence. This empirical configuration corroborated the a priori triadic measurement architecture postulated by theoretical frameworks. In addition, inter-factor correlations remained constrained within psychometrically permissible bounds ($\Delta\lambda < 0.30$), affirming discriminant validity across the latent dimensions. Furthermore, convergent validity was confirmed through average variance extracted (AVE) values >0,50, while discriminant validity was established once more using the Fornell–Larcker criterion (Hair et al., 2019).

Table 3. Standardized factor loadings and Cronbach's alpha, AVE, and CR values of factors

No.	Construct	Item	Standardized factor loadings	Cronbach's Alpha	Average variance explained (AVE)	Composite reliability (CR)
1	*2*	*3*	*4*	*5*	*6*	*7*
1	Software performance	SoftPerf3	0.843	0.964	0.659	0.906
		SoftPerf2	0.812			
		SoftPerf5	0.810			
		SoftPerf1	0.804			
		SoftPerf4	0.789			
2	Process performance	ProPerf5	0.831	0.969	0.629	0.922
		ProPerf4	0.827			
		ProPerf6	0.820			
		ProPerf2	0.818			
		ProPerf7	0.783			
		ProPerf1	0.765			
		ProPerf3	0.702			
3	Business performance	BusPerf5	0.850	0.952	0.520	0.927
		BusPerf10	0.816			
		BusPerf1	0.814			
		BusPerf12	0.503			

Table 3 cont.

1	2	3	4	5	6	7
		BusPerf6	0.753			
		BusPerf4	0.752			
		BusPerf7	0.693			
		BusPerf8	0.691			
		BusPerf2	0.670			
		BusPerf3	0.667			
		BusPerf9	0.609			
		BusPerf11	0.477			

Source: Authors' own elaboration.

Reliability is a prerequisite for valid measurement. In addition, the internal consistency of scales measuring software, process, and business performance was evaluated using both Composite Reliability (CR) and Cronbach's alpha coefficients as presented in Table 3. All dimensions exhibited excellent reliability, with CR and Cronbach's alpha values exceeding 0.90 and 0.95, respectively, for all sub-dimensions, surpassing the threshold for internal consistency (Nunnally & Bernstein, 1994) or acceptable thresholds where values below 0.50 were deemed unacceptable following George and Mallery's (2010). Thus, the scales were retained for further analysis.

3.4. Data analysis method

Hypothesis testing and mediation analysis were conducted using SPSS 28 and the PROCESS Macro v4.0 (Hayes, 2022), a robust statistical tool for path analysis and mediation modeling. Model 4 of the macro was employed to simultaneously test the direct effect of software performance on business performance and the indirect effect mediated by process performance. This approach aligns with contemporary methodological standards for examining complex interdependencies in organizational research (Zhao et al., 2010).

4. Findings

Before mediation modeling, a Pearson correlation analysis was done, as presented in Table 4. The findings revealed statistically significant positive correlations among all variables ($p < 0.01$). Notably, process performance demonstrated strong direct relationships with both software performance ($r = 0.768$, $p < 0.01$) and business performance ($r = 0.708$, $p < 0.01$), underscoring its pivotal role in driving organizational outcomes. The relatively weaker correlation between software performance and business performance ($r = 0.654$, $p < 0.01$) suggests that software's impact on business outcomes may be mediated.

Table 4. Pearson correlation analysis results

No.	Variable	Arithmetic mean	Standard deviation	1	2	3
1	Software performance	3.771	1.080	1.00		
2	Process performance	3.908	1.097	0.768*	1.00	
3	Business performance	3.514	0.886	0.654*	0.708*	1.00

* Correlation is significant at 0.01.

Source: Authors' own elaboration.

To evaluate the mediation effect, the bias-corrected bootstrap method was employed with 5,000 resamples and 95% confidence intervals (CIs), including the lower limit confidence interval (LLCI) and the upper limit confidence interval (ULCI). Although normality checks conducted on the aggregate scale-level data indicated that all values fell within the acceptable range of ±1.5, consistent with acceptable thresholds (Tabachnick & Fidell, 2013), bootstrapping was applied not due to any observed violations, but rather as a robustness strategy in recognition of potential risks inherent in the population context. This non--parametric technique is preferred over traditional methods, such as Baron and Kenny's (1986) causal steps approach and the Sobel test, as it avoids assumptions of normality and enhances statistical power, particularly in small to moderate sample sizes (Hayes, 2022). Moreover, its use aligns with methodological recommendations that advocate for bootstrapping in research-based in emerging economies such as Türkiye's logistics industry, where latent heterogeneity, infrastructural variability, and contextual noise may introduce non-normality at the item or subgroup level. Accordingly, the application of bootstrapping in this study served as a precautionary measure to enhance the reliability of parameter estimates and confidence intervals in regression-based analyses, including those performed with the PROCESS Macro. This approach ensures that statistical inferences remain valid and robust even in the presence of potential unobserved non-normality.

Results of the mediation analysis, including standardized path coefficients and effect sizes, are summarized in Table 5.

Table 5. Mediation model analysis results

Variables				
Specification	Process performance (mediator)	CI (95%)	Business performance	CI (95%)
Model	ß / SE	LLCI / ULCI	ß / SE	LLCI / ULCI
Software performance	0.768	0.6650 – 0.8961	0.268	0.0628 / 0.3761
Process performance (M = mediator)	–	–	0.503	0.2516 / 0.5599
Constant	0.2123	0.5113	0.2123	0.6809 / 1.5213
Model summary	$R^2 = 0.5905$	–	$R^2 = 0.5310$	–
Values	F = 178.7851	p = 0.000	F = 69.6249	p = 0.000

Source: Authors' own elaboration.

The mediation analysis (presented in Table 6) revealed that the performance of the TMS software exerted both direct and indirect effects on overall business performance, with standardized beta coefficients (β) in Türkiye's logistics industry. Following Hayes' (2022) guidelines, the bootstrap analysis confirmed a statistically significant mediation effect, as evidenced by a 95% bias-corrected confidence interval (CI) that did not include zero. This supported the hypothesis that process performance mediates the relationship between software performance and business performance in Türkiye's logistics industry, a finding aligned with digital transformation frameworks in emerging economies.

Table 6. Mediation effect on process performance

Direct effect								
Software performance	Business performance		Effect	S. E.	LLCI	ULCI	t	p
			0.268	0.1088	0.132	0.560	2.7733	0.00
Indirect effect								
Software performance	Process performance	Business performance	0.386	0.1088	0.132	0.560	–	
Total effect			0.654	0.056			9.6229	0.00

Source: Authors' own elaboration.

In terms of paths:

a) Software performance → process performance: TMS software performance demonstrated a strong, statistically significant positive effect on process performance ($\beta = 0.768$, 95% CI [0.665, 0.896], $p < 0.01$).

b) Process performance → business performance: process performance significantly mediated the software-business performance linkage, with a robust positive effect on overall business outcomes ($\beta = 0.503$, 95% CI [0.252, 0.560], $p < 0.001$).

The total effect of TMS software performance on business performance ($\beta = 0.654$, $p < 0.001$) included a significant indirect effect mediated by process performance ($\beta = 0.3867$, 95% CI [0.1182, 0.4589], $p < 0.001$). With such values in hand, the proportion mediated by process performance was 0.59, indicating that approximately 59% of the total effect of software performance on business performance is transmitted through this mediator.

5. Discussion

The empirical evidence indicates that software performance influences business performance through both direct and process-mediated pathways, with the mediated mechanism exhibiting greater explanatory power. This configuration directly engages two foundational debates in the digital value literature: first, whether IT capabilities generate value autonomously or only through process mechanisms, and second, whether such mechanisms are structurally stable or contingent upon contextual conditions. The discussion below advances the theoretical interpretation of these findings by situating them within RBV, BPM, and IT value realization streams.

Within the scope of this study, TMS software performance reflects a bundle of functional, integrative, and analytical capabilities that support managerial decision-making. Conceptually, these capabilities can be interpreted not only as operational tools but also as indicators of business-level digital maturity. High-performing TMS solutions enable improved planning quality and decision coherence, which are theoretically aligned with dynamic capability formation rather than static resource possession. This framing elevates software performance from a technical attribute to a strategic construct within capability-based theory.

H1 posits a direct positive relationship between software performance and business performance. The empirical support for this hypothesis introduces an important theoretical refinement to RBV-aligned assumptions. Classical RBV formulations emphasize that resources become valuable only when embedded in complementary organizational routines. However, the observed direct effect suggests that, under conditions of institutional frictions and coordination inefficiencies, modular digital capabilities may function as quasi-autonomous value generators. Theoretically, this challenges a strict process-contingent interpretation of IT value and supports a more pluralistic logic in which digital resources can yield partial rents even in the absence of full process alignment.

H2 proposes that software performance enhances process performance, a relationship strongly supported by the findings. From a BPM perspective, this reinforces the conceptualization of digital infrastructures as carriers of decision-making quality and procedural coherence. Theoretically, however, the magnitude of this effect extends existing BPM theory by highlighting a compensatory role of digital systems. Rather than merely refining already efficient routines, software-enabled decision support in constrained environments appears to substitute for missing institutional and infrastructural support. This suggests that BPM capabilities may play qualitatively different roles across contexts, a distinction that remains under-theorized in mainstream process management literature.

H3 advances the mediating role of process performance in the relationship between software and business performance. The dominance of this indirect pathway aligns with IT value chain arguments that locate economic payoff within managerial process performance rather than technological possession alone. Significantly, the findings extend this stream by demonstrating that process performance functions not as a secondary conduit but as a structural amplifier of digital value under high-friction conditions. The mediation mechanism observed here does not simply coexist with the direct effect; it conditions the scale and reliability of value realization, thereby reinforcing the centrality of process capability in translating digital potential into competitive outcomes. Accordingly, the mediation results should be interpreted as software performance improving business performance primarily through improvements in decision-making/strategic process performance, rather than through direct operational workflow efficiency.

As seen, the empirical evidence supports H1, H2, and H3. Beyond the basic mediation effect, the analysis reveals a more nuanced mechanism. The results of the analysis indicate that software performance has a significant positive effect on business performance, both directly and indirectly through process performance. According to the classification framework proposed by Zhao et al. (2010), since both the direct and indirect effects are significant and point in the same direction, this relationship is identified as “complementary mediation”. This finding demonstrates that process performance does not merely serve as an intermediary; it also acts as a structural amplifier, enhancing the translation of software capabilities into organizational value.

Beyond hypothesis confirmation, the results offer two broader theoretical extensions. First, contrary to prior studies that report negligible direct IT effects once process alignment is considered, this study identifies a statistically significant direct path from software performance to business performance. This divergence suggests that dominant generalizations in the IT value literature – largely derived from high-efficiency economies – may underestimate the intrinsic leverage of digital functionalities in environments where software compensates for procedural or infrastructural deficiencies. Theoretically, this points to a context--sensitive boundary condition for established IT value models.

Second, the strength of the mediation effect appears contingent on the institutional characteristics of the empirical setting. In coordination-deficient environments such as Türkiye's logistics industry, software-induced improvements in decision-making performance likely substitute for absent system-level efficiencies, thereby intensifying the mediation mechanism. This implies that process maturity operates not merely as a complement to digital resources but as a necessary converter of software potential into performance gains. From a theoretical standpoint, this finding challenges the assumption of structural universality in IT-process-performance relationships and calls for greater contextualization in digital capability models.

Taken together, the findings articulate a dual-channel logic of digital value realization in which software performance contributes to business outcomes both directly and, more prominently, through process conversion mechanisms. This contributes to the integration of RBV and BPM by demonstrating that the value of digital resources is neither purely intrinsic nor exclusively process-dependent, but predominantly process-transduced under institutional constraints. Theoretically, the study suggests that models developed in high-efficiency contexts may systematically understate the strength of mediation in emerging economies, where processes function not only as enhancers but also as essential translators of digital capability into competitive advantage.

6. Conclusions

This study demonstrates that software performance influences business performance through two pathways: a direct effect and a more substantial indirect effect mediated by process performance. Adhering to a conservative analytical approach by combining traditional parametric assumptions with non-parametric resampling methods to ensure the robustness of inferences in a contextually complex empirical setting, these findings contribute to the discourse on digital value creation by empirically validating process performance as a critical mediator, a mechanism that has been under-explored in logistics research within emerging economies (World Bank, 2023). The dominance of the indirect effect aligns with the RBV, which posits that software's strategic value depends on complementary process capabilities (Barney, 1991; Kettinger et al., 2021).

Anchored in the RBV and process-oriented perspectives, this study provides empirical evidence that software performance influences business performance through two distinct pathways: a direct channel and a more substantial indirect channel mediated by process performance. The dominance of the mediated effect demonstrates that software does not create value as a purely technological artifact but as a capability that attains strategic relevance when metabolized through organizational processes. This finding extends the digital-value discourse into an emerging-economy logistics context, where structural frictions heighten the necessity of process translation for value realization.

Beyond its theoretical contribution, the results carry salient managerial implications, indicating that technology adoption, on its own, is an insufficient route to performance improvement; value materializes when software investments are structurally integrated into process governance. In practical terms, logistics businesses should: (i) align software features with explicit process targets instead of deploying them in isolation, (ii) institutionalize monitoring dashboards to quantify digital returns at the process level, (iii) identify and remove residual manual bottlenecks through periodic audits, (iv) build BPM capabilities to increase the absorptive capacity of digital tools, and (v) replace siloed IT deployment with cross-functional coordination mechanisms. These implications move the discussion from "technology acquisition" to "technology-enabled process institutionalization", a distinction with direct relevance for businesses operating under infrastructure and coordination deficits.

Despite its contributions, this study has several limitations. First, the data are limited to the logistics industry in Türkiye, which may limit the generalizability of the findings to other geographic contexts. Second, a limitation is that process performance is measured as decision-making/strategic process performance; future research should test whether the same mechanism holds when process performance is operationalized using purely operational logistics workflow indicators. Third, reliance on self-reported, cross-sectional data introduces the potential for common-method bias and precludes definitive causal inferences about the temporal sequence from software adoption to process and business outcomes. Fourth, this study does not account for potential confounding variables, such as business size or sub-industry specialization, nor does it incorporate potential moderators, such as integration depth, digital maturity, or knowledge-sharing routines, which could influence the strength of the observed relationships.

There is a specific conceptual limitation on the operationalization of software performance, as well. While the study treats this construct as a unified formative index to answer the pragmatic question of whether investing in a better overall TMS system, considering all its facets, leads to improved business outcomes through better processes, this approach inherently masks the distinct effects of its underlying dimensions (e.g., functionality, service quality, technological competence). Future research would benefit from disaggregated analysis to identify which specific software capabilities are most critical to driving process efficacy.

These limitations delineate clear avenues for further scholarly inquiry. Future studies should:

a) incorporate the control variables (e.g., business size, industry segment) and test potential moderators (e.g., integration depth, absorptive capacity) to enhance the model's robustness and precision;
b) investigate emerging technologies such as blockchain and the IoT as potential amplifiers or disruptors of the mediation mechanism;
c) examine the influence of contextual boundary conditions, including cultural, regulatory, and process-maturity conditions;
d) employ longitudinal designs and triangulate perceptual measures with operational indicators to uncover temporal effects;
e) conduct cross-industrial and cross-regional replications to assess the generalizability of the process-mediated value creation model.

Notwithstanding these limitations, the results provide strong evidence that digital value in logistics is not technology-inherent but process-converted, offering a generalizable explanatory lens for understanding why identical software investments yield asymmetric performance outcomes across institutional environments.

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Conflict of interest

The author(s) declare(s) that there is no conflict of interest.

Author contributions

Bükra Doganer – 52% (research concept and design, collection and/or assembly of data, data analysis and interpretation, writing the article).
Gültekin Altuntaş – 48% (writing the article, critical revision of the article, final approval of the article).

Ethics statement

This study involved human participants. Participation was voluntary and anonymous, and informed consent was obtained before participation. According to applicable institutional and national regulations of Istanbul University, formal ethical approval was not required for this type of study.

Data availability statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Appendix

Construct, variables, and their respective items used in the measures

Constructs/ variables	No.	Subconstructs/ variables	Item related to
Software performance (Doğaner Duman & Altuntaş, 2024; Erol & Ferrell, 2003; Sahay & Gupta, 2003; Şen et al., 2009; Umble et al., 2003; Wei & Wang, 2004)	1	Technological competence	Information flow and transparency
			Ease of use
			Customized reporting
	2	Service	Training
			After-sales support
			Error management
			Reliability
	3	Functionality	Load tracking
			Software customization
			Software modules

Constructs/ variables	No.	Subconstructs/ variables	Item related to
	4	Cost and prices	Software license cost
			Update cost
			Software module cost
	5	Vendor performance	Industrial knowledge
			References received
			Reputation
Process performance (Aydıner, 2016; Ravesteyn et al., 2010; Bayraktar et al., 2009; Elbashir et al., 2008; Luo et al., 2012; Mahmood & Soon, 1991; Mclaren et al., 2011; Mithas et al., 2011; Ongena & Ravesteyn, 2020).	1	The overall business situation analysis aligns with the unit-level analyses.	
	2	Our business has a long-standing tradition of strategic planning.	
	3	Strategic decisions are made effectively in our business.	
	4	Our business can analyze customer and market information quickly and effectively.	
	5	Decision-making processes in our business are short.	
	6	Our business's organizational intelligence enables timely access to accurate and comprehensible information.	
	7	In our business, problems and opportunities are quickly identified in strategic decisions.	
	8	There is alignment among decisions taken by different units in our business.	
Business performance (Vickery et al., 1993; Wilcox King & Zeithaml, 2001; Yamin, 1999)	1	Our return on investment is higher than our competitors'.	
	2	Our average employee productivity is higher than that of our competitors.	
	3	Our response time to customer complaints is faster than our competitors.	
	4	Our market share exceeds that of our competitors.	
	5	Our sales volume is higher than that of our competitors.	
	6	Our cost of service/product is lower than that of our competitors.	
	7	Our growth rate is higher than our competitors'.	
	8	Our customer satisfaction rate is higher than our competitors'.	
	9	The number of our customers is steadily increasing.	
	10	Overall, our profitability level is higher than that of our competitors.	
	11	The number of employees we have is sufficient.	
	12	The convertibility of our investments into cash is higher than that of our competitors.	

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