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ENGINEERING ECONOMIC EVALUATION OF DIGITAL SUPPLY CHAIN MANAGEMENT PRACTICES IN CHINESE INDUSTRIAL ENTERPRISES

Sun Ke, Ph. D. student
Belarusian National Technical University
Minsk, Republic of Belarus
Scientific supervisor: Doctor of Economic Sciences, Associate Professor Yakushenko K. V.

Abstract. This study constructs the "cost-benefit paradox" in the digital supply chains of industrial enterprises in China based on an engineering economics assessment. It finds critical bottlenecks in process re-engineering and talent reserves and suggests the necessity for shifting from technological leadership to economic viability and increased development of interdisciplinary talents.

In the context of global manufacturing's digital and intelligent transformation and the strategic drive of China toward becoming a ‘manufacturing powerhouse’, digital supply chains have become crucial in strengthening core industrial competitiveness. Currently, however, Chinese industrial practices are permeated by a strong contradiction: faced as they are with massive investment in technologies, there is a lack of systematic assessment of actual economic benefits, with many projects falling into a ‘mismatch between input and output’. This makes it pressing to explore this issue through an engineering economics lens, which underlines serious evaluation of costs, benefits, and risks associated with technological solutions. Therefore, this paper seeks to apply engineering economics to diagnose the status quo of the management of digital supply chains in Chinese industrial enterprises. It emphasizes ascertaining actual created economic value and analyzing the existing bottlenecks, to guide business investment away from chasing technological leadership toward focusing on value-creation prioritization. This provides an economically rational foundation for advancing high-quality industrial transformation.

The core principles of engineering economics have been brought into the analysis and translated the effect of technological application into quantitative economic and financial languages. Cost-related indicators directly measure digitalization's capacity to reduce operational expenditure and thus represent the most immediate manifestation of benefits [1]. Asset efficiency metrics, including inventory turnover and cash conversion cycle, appraise how digitalization optimizes resource allocation and accelerates capital flow, reflecting the level of lean management. Further, return on investment metrics examine the long-term economic viability of technological investments from the perspective of value creation. Finally, service and value metrics connect internal efficiency with external customer value and market competitiveness; together, they form a comprehensive yardstick of assessment that ranges from internal cost control to external value realization. Examining the current state of digital supply chain management in Chinese industrial enterprises through this framework reveals a complex and markedly differentiated multi-dimensional economic landscape. Regarding technology application breadth, the penetration of IoT, big data, and cloud computing technologies across procurement, production, and logistics is accelerating rapidly. However, this is frequently accompanied by a ‘cost-benefit paradox: Despite initial technological deployments, many enterprises fail to translate substantial upfront investments into tangible financial performance gains. This occurs due to low system integration, inconsistent data quality, and disconnects from operational workflows, resulting in diminished marginal returns on technological investments [2]. This phenomenon of technological silos further exacerbates challenges in process coordination levels. The absence of unified, transparent information-sharing platforms and collaborative mechanisms both internally and with upstream/downstream partners results in severe information barriers and fragmented decision-making across supply chain segments. Such low-level coordination

not only fails to leverage the inherent efficiency gains of digitalization but, by amplifying the bullwhip effect, results in abnormally high inventory levels and inaccurate demand forecasting across the entire chain. This ultimately manifests as a significant surge in transaction costs-including negotiation, coordination, and oversight-eroding corporate profit margins. Concurrently, resource allocation efficiency directly depends on an organization's data-driven decision-making capabilities. A handful of leading enterprises have optimized inventory turnover rates and substantially enhanced fixed asset utilization by establishing precise forecasting, planning, and scheduling models. This revitalizes dormant assets and accelerates capital turnover. However, the resource allocation of most enterprises still relies on traditional experience, resulting in concurrent idle capacity and inventory backlogs. This causes severe resource wastage and asset inefficiency. At its core, this divergence in economic performance stems from organizational structure and decision-making mechanisms. When supply chain departments are positioned as passive 'cost centers' rather than proactive 'value centers', and decision-making processes remain trapped in traditional hierarchical approvals lacking digital empowerment, their response to market shifts inevitably becomes sluggish. The opportunity cost of missed business opportunities is substantial. Conversely, enterprises that have established flat, data-driven organizations can integrate resources and respond to demand more swiftly. This allows them to capture more value in dynamic markets and turn digital investments into true competitive differentiators and financial returns. Based on this multi-dimensional diagnosis, this study crystallizes three core findings: First, the disparities in development are strikingly pronounced; a minority of leading enterprises, leveraging resource and first-mover advantages, has moved forward to the 'value extraction' stage, using data for precision decision-making and model innovation, while most SMEs are constrained to isolated technology pilot schemes. The gap between these two sets of organizations is huge in terms of supply chain cost control, asset efficiency, and final economic benefits, which has shaped an obvious digital gap. Second, the critical choke point that hinders economic benefits is not technological sophistication, but the serious lag of process reengineering and organizational change required to match it. In addition, traditional departmental silos and outdated mechanisms for decision-making have made the value of technological investment unable to be generated in the reshaped value chains. Lastly, an institutional blind spot widely exists in investment; enterprises often prioritize hardware and software investment while seriously neglecting the cultivation and retention of core talent in data science, business analytics, and engineering economics assessment, which results in the predicament of having systems without intelligence and data without insight. Based on the above findings, this paper puts forward: To enterprises, the core of digital strategy should shift from pursuing 'technological leadership' to ensuring 'economic viability'. It should be based on establishing an overall economic benefit tracking accountability system throughout the project cycle-from project initiation and implementation to post-evaluation-and making sure every single investment serves to create value. To government and academia, the joint promotion of benchmark cases for excellent 'digital supply chain economic benefit audit' should be conducted to provide a clear route for SMEs.

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