

Evaluating the Potential of Quantum Computing for Supply Chain Optimization in SMEs

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Abstract—The accelerating complexity of global supply chains, particularly among small and medium-sized enterprises (SMEs), presents challenges that exceed the capabilities of conventional computational models. Quantum computing, with its inherent ability to process vast solution spaces through superposition and entanglement, offers a transformative approach to supply chain optimization. This study evaluates the feasibility and potential impact of applying quantum and hybrid quantum–classical algorithms—such as the Quantum Approximate Optimization Algorithm (QAOA) and quantum annealing—to logistics scheduling, demand forecasting, and inventory management in SMEs. It critically analyzes algorithmic efficiency, scalability, and cost–benefit ratios within limited computational infrastructures. The research integrates insights from operations research, quantum algorithm design, and management science to identify viable entry points for SME adoption. Findings suggest that while quantum computing remains in the NISQ (Noisy Intermediate-Scale Quantum) stage, near-term applications through cloud-based hybrid platforms could significantly enhance decision accuracy, resource allocation, and resilience against supply chain disruptions.

■ In an era of globalized production networks and data-driven logistics, supply chain optimization has become a crucial determinant of competitiveness, particularly for small and medium-sized enterprises (SMEs) [6]. However, SMEs often face resource constraints—financial, technological, and computational—that limit their ability to implement advanced optimization and predictive analytics tools. The growing complexity of supply chains, characterized by volatile demand, disruptions, and sustainability pressures, demands solutions that exceed the capabilities of classical computational models [5]. Within this context, quantum computing emerges as a

disruptive paradigm capable of transforming supply chain decision-making through its ability to explore exponentially large solution spaces efficiently.

Unlike classical methods, which evaluate one potential solution at a time, quantum algorithms exploit superposition and entanglement to analyze multiple configurations simultaneously. Algorithms such as the Quantum Approximate Optimization Algorithm (QAOA) and quantum annealing have shown strong potential for addressing NP-hard problems central to logistics—route optimization, scheduling, and multi-tier inventory management [7]. When integrated with classical optimization routines, these hybrid quantum–classical frameworks can improve both convergence speed and solution

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