
**Department of Computer Science**
**St. Francis Xavier University**

**M.Sc. Thesis Proposal Presentation**

# An Optimization Framework for Privacy-Preserving Access Control in Blockchain-Based Supply Chain Management

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**Date:** Thursday, December 11th, 2025
**Time:** 10:30 AM
**Location:** Annex 113

**Abstract:** Modern supply chain management (SCM) is becoming more complex, involving diverse stakeholders and constant flow of goods, information, and capital. While, Blockchain technology provides transparency, traceability, and immutability, but it faces challenges with scalability, efficiency, and privacy. Due to the transparent nature of blockchain, if sensitive corporate or consumer data is fully exposed on blockchain, confidentiality is jeopardized, which may result in a gap between transparency and privacy in decentralized SCM.

This study presents an optimization-based framework for privacy-preserving access control in blockchain-enabled supply chains. The goal is to protect sensitive information while preserving the utility of non-sensitive data for analytics and decision-making. To build a sensitive data matrix, we have utilized the DataCo Global Supply Chain dataset and sensitive fields were identified using the FP-GROWTH algorithm. A two-phase process—data sanitization and restoration—was then carried out, guided by optimal cryptographic keys, which is created by the updated Grey Lag Goose Optimization (GGO) algorithm. A multi-objective fitness function was designed to minimize hiding failure, information loss, false modifications, and data distortion while achieving a balance between privacy and utility.

Using a dataset with 5870 sensitive rules, the updated GGO algorithm was improved by elitism, adaptive group sizing, guided restarts, and oppositional re-initialization and it produced optimal binary sanitization keys that achieved perfect privacy ($P=1.0$) and minimal utility degradation ($L_{IL}=0$, $L_{FM}=0$, $L_{MD}=0.25$). In comparison to the baseline GGO and the WNU versions, these results show a significant improvement in convergence stability and optimization accuracy.

The proposed GGO-based framework reduces data distortion, ensures privacy, and outperforms existing optimization strategies in terms of accuracy. The integration of Ethereum smart contracts enables secure and immutable transmission of sanitized data, while authorized recipients can accurately restore sensitive information. This optimized framework effectively bridges the transparency–privacy gap in supply chain management, creating a safe, robust, and utility-aware environment for global operations.