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Integrating Blockchain in Nuclear Fuel Supply Chains for Transparency of Hazardous Materials Flow

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Abstract

Blockchain technology is a systematic record-keeping of data, termed "ledger-keeping", such that once a record is created, it is saved on multiple servers, shared with all parties on the network, and locked to disable tampering. The core competencies that govern blockchain are transparency, immutability (tamper-proof) and decentralization. These features of blockchain present a powerful solution to eliminate the transparency issues that currently plague nuclear supply chains and inhibit effective risk management.

Risk management of nuclear supply chains is critical because it involves transport of fuel materials that can potentially be developed into nuclear weapons. The supply chain of nuclear fuel is a multi-stage process in which the raw material suppliers, fuel processers, and end-users (reactors) are commonly located across multiple countries. Each stage of transportation is prone to the risk of unauthorized removal of fuel material from the shipment. Heightening this risk is the lack of visibility of material during international transport. Such long transit times allow for any event of theft to go unnoticed until the shipment reaches the destination. For detection of theft, the IAEA calls for measurements and record-keeping of the gross weight of each shipment at every shipper's and receiver's end, at every tier of the supply chain, a procedure known as nuclear material accounting. A second risk is that these record entries can be tampered with, even by authorized workers, for concealment of theft. In order to reduce these risks, this paper proposes the application of blockchain in global nuclear fuel supply chains

Integration of blockchain into nuclear supply chains can enable the mitigation of these risks by facilitating traceability of materials, allowing timely and precise detection of location of theft and eliminating the contingency of record-tampering through digitization of the nuclear material accounting registry. This paper explores the applicability of blockchains in the nuclear context by: (1) Mapping the nuclear fuel supply chain (2) Identifying and prioritizing associated risks using FMEA and (3) Proposing a framework of the blockchain infrastructure needed to reduce the occurrence of the identified risks.

Keywords
Smart Supply Chains, Risk Management, Blockchain, Nuclear Materials, Material Accounting

Biographies

Aamirah Mohammed Ashraf is an MASc. candidate at the University of Windsor with a research interest in Intelligent Supply Chains, Reverse Logistics and Sustainable Development. Her master's thesis addresses the challenges of maximizing profitability in reprocessing of end-of-use electronics.

Walid Abdul Kader is a professor at the University of Windsor with expertise in Optimization, Operations Research and Manufacturing. His current research interests include Remanufacturing, Green Machining and Reverse Logistics.