

1. Miner (Registers Diamond)

- ◆ **Diamond ID** (Unique identifier)
- ◆ **Raw Diamond Image Hash** (Stored on IPFS/AWS S3, hash stored on-chain)
- ◆ **Weight (in carats)**
- ◆ **Mining Location**
- ◆ **Timestamp**
- ◆ **Miner's Address (Ethereum Account)**

 **Verification at next step:** The **Rough Trader** verifies if the **image & weight match** before proceeding.

2. Rough Trader (Verifies & Adds New Info)

- ◆ **Verifies Miner's Data** (Image, Weight)
- ◆ **New Image Hash** (After processing, stored on IPFS)
- ◆ **Weight after initial processing**
- ◆ **Transaction Details (Seller & Buyer Addresses)**
- ◆ **Timestamp**

 **Verification at next step:** The **Diamond Cutter** checks if weight & condition are consistent.

3. Diamond Cutter (Cuts Raw Diamond)

- ◆ **Verifies Previous Data**
- ◆ **Cut Diamond Image Hash** (New image on IPFS)
- ◆ **New Weight (after cutting loss)**
- ◆ **Cut Type (Round, Princess, etc.)**
- ◆ **Timestamp**
- ◆ **Cutter's Ethereum Address**

 **Verification at next step:** Polisher checks for weight & cut consistency.

4. Diamond Polisher (Refines & Polishes)

- ◆ **Verifies Previous Data**
- ◆ **Polished Diamond Image Hash**
- ◆ **Final Weight (post-polishing loss)**
- ◆ **Clarity & Color Grade (GIA Standards)**
- ◆ **Timestamp**
- ◆ **Polisher's Ethereum Address**

- Verification at next step:** Diamond Trader ensures proper certification & quality check.
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5.Diamond Trader (Markets to Wholesalers)

- ◆ Verifies Previous Data
- ◆ Trade Certificate Hash (GIA or other certification bodies)
- ◆ Market Value
- ◆ Buyer & Seller Ethereum Addresses
- ◆ Timestamp

- Verification at next step:** Manufacturer confirms quality & pricing.
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6.Diamond Manufacturer (Sets for Jewelry)

- ◆ Verifies Previous Data
- ◆ Jewelry Type (Ring, Necklace, etc.)
- ◆ Final Product Image Hash
- ◆ Timestamp
- ◆ Manufacturer's Ethereum Address

- Verification at next step:** Wholesaler ensures authenticity.
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7.Diamond Wholesaler (Bulk Sells)

- ◆ Verifies Previous Data
- ◆ Wholesale Price
- ◆ Bulk Transaction Details
- ◆ Timestamp
- ◆ Wholesaler's Ethereum Address

- Verification at next step:** Retailer ensures proper sourcing.
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8.Diamond Retailer (Sells to End Users)

- ◆ Verifies Previous Data
- ◆ Retail Price
- ◆ Final Customer Ethereum Address (Optional)
- ◆ Timestamp
- ◆ Retailer's Ethereum Address

-  **Verification at next step: End user checks full history via blockchain.**
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9.End User (Verifies Authenticity)

- ◆ Checks Complete Diamond Journey
- ◆ Verifies GIA Certificate
- ◆ Matches Image Hashes with IPFS Storage

Supply Chain Management in the Diamond Industry for Traceability and Authenticity Using Blockchain

0. Introduction

- The diamond industry faces challenges such as fraud, unethical sourcing, and lack of transparency.
- Traditional supply chains are centralized, making them vulnerable to counterfeiting and misrepresentation.
- Blockchain provides a decentralized and immutable ledger to enhance traceability and authenticity.
- It ensures secure ownership tracking, fraud prevention, and trust among stakeholders.
- This presentation explores how blockchain can be integrated into diamond supply chain management for improved security and transparency.

1. Research Objective

- To enhance the traceability and authenticity of diamonds throughout the supply chain using blockchain technology.
- To prevent fraudulent practices, ensure ethical sourcing, and maintain transparency at each stage of the diamond lifecycle.
- To securely store and verify the ownership, weight, certification, and transaction history of each diamond.

2. Literature Review

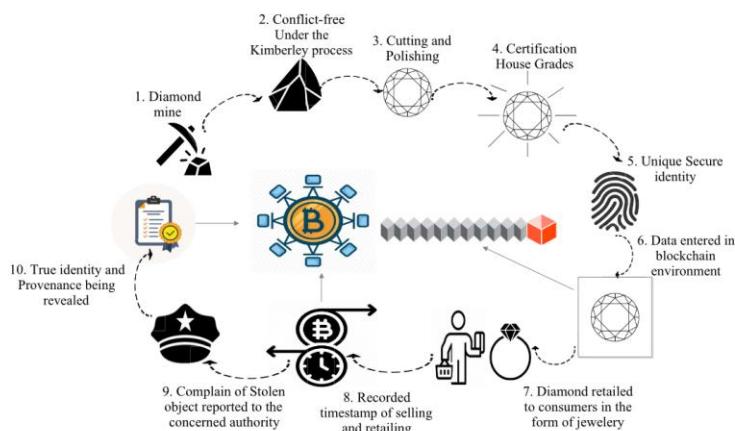
- **Traditional Supply Chains:**
 - Centralized and opaque.
 - Prone to fraud, counterfeit diamonds, and unethical sourcing.
 - Lack of real-time verification.
- **Existing Blockchain Applications:**
 - Implementation in food, pharmaceutical, and luxury industries.
 - Proven use of smart contracts for automation and trust.
 - Challenges in adoption due to scalability and regulatory concerns.
- **Blockchain for Diamonds:**
 - Emerging projects like Everledger and De Beers' Tracr.
 - Need for a decentralized, tamper-proof ledger to authenticate diamond transactions.

TABLE I
SUMMARY OF LITERATURE REVIEW ON BLOCKCHAIN-BASED SUPPLY CHAIN

No.	Paper Title (with Authors)	Year	Key Focus	Challenges Addressed	Research Gaps Identified
1	Blockchain Technology Overview (Yaga et al.)	2019	Provides a foundational understanding of blockchain technology, including its architecture, consensus mechanisms, and potential applications.	Scalability, Security	Need for industry-specific blockchain applications and real-world case studies.
2	Blockchain for Supply Chain Management (Wannenwetsch et al.)	2022	Reviews the use of blockchain in supply chain management, identifying key benefits such as transparency, efficiency, and fraud prevention.	Trust, Data Privacy	Lack of large-scale real-world implementations and cross-industry adoption.
3	Auditability and Transparency in Blockchain Supply Chain (Sezer et al.)	2023	Proposes a privacy-preserving blockchain framework to enhance auditability and transparency while ensuring data confidentiality.	Privacy, Auditability	Need for lightweight privacy-preserving solutions with reduced computational cost.
4	Blockchain-Based Diamond Authentication (Choi et al.)	2024	Explores the potential of blockchain for diamond authentication, preventing counterfeiting, and enhancing certification processes.	Fraud, Counterfeiting	Scalability and cost-effectiveness of blockchain-based diamond verification.
5	Blockchain for Pharmaceutical Supply Chain (Jha et al.)	2024	Discusses blockchain applications in pharmaceutical supply chains to prevent counterfeit drugs and improve traceability.	Counterfeit drugs, Trust	Need for global regulations for pharmaceutical blockchain adoption.
6	Hyperledger-Based Jewelry SCM (Pise et al.)	2024	Proposes a blockchain-based solution for jewelry traceability using Hyperledger Fabric to enhance tracking and transparency.	Transparency, Tracking	Integration challenges with existing jewelry supply chains.
7	Blockchain for Food Traceability (Sharma et al.)	2024	Analyzes blockchain's role in food safety, improving traceability, and preventing food fraud.	Trust, Food Safety	High computational cost and scalability concerns of public blockchain models.
8	Diamond Industry Blockchain Challenges (Thakker et al.)	2024	Identifies opportunities and challenges in implementing blockchain in the diamond industry, focusing on transparency and regulatory issues.	Scalability, Regulation	Lack of standardization and interoperability in diamond traceability solutions.

3. Research Gap

- Lack of a comprehensive decentralized solution for verifying diamonds at every stage.
- Current systems focus on partial traceability rather than full supply chain authentication.
- Need for efficient, cost-effective, and transparent verification methods using blockchain.



4. Research Contribution

- Proposing a blockchain-based model for complete diamond traceability.
- Implementing smart contracts for authentication at each supply chain stage.
- Ensuring secure, verifiable, and tamper-proof transaction records.

5. Proposed Work

- **Stakeholders:**
 - Miner → Rough Trader → Diamond Cutter → Diamond Polisher → Diamond Trader → Diamond Manufacturer → Diamond Wholesaler → Diamond Retailer → End User.
- **Authentication at Each Level:**
 - Each entity must verify the previous entity's details before proceeding.
- **Information Stored at Each Level:**
 - **Miner:** Diamond ID, weight, image, mine location, timestamp.
 - **Rough Trader:** Verification of miner's details, resale value, authentication proof.
 - **Diamond Cutter:** Cutting style, weight changes, certification proof.
 - **Diamond Polisher:** Polishing details, new images, weight adjustments.
 - **Diamond Trader:** Resale details, diamond grade verification.
 - **Diamond Manufacturer:** Jewelry integration details, customer receipts.
 - **Diamond Wholesaler & Retailer:** Final sale records, customer verification.
 - **End User:** Ownership transfer, warranty registration.
- **Verification Process:**
 - At each step, the new entity cross-checks previous records before adding new details.
 - Immutable records prevent fraud.

6. Implementation

Technology Stack:

- **Frontend:** Vue.js for user interaction.
- **Backend:** Node.js with Express.js for API handling.
- **Blockchain:** Ethereum for decentralized storage.
- **Database:** IPFS for images, MongoDB for metadata.
- **Smart Contracts:** Solidity-based contract for transaction automation.
- **Tools:** MetaMask for local development.

Smart Contract Functionality:

- **Register Diamond:** Miner registers the diamond's initial details.
- **Transfer Ownership:** Each entity updates records upon receiving the diamond.
- **Verify Diamond:** Anyone can check the authenticity and transaction history.
- **Role-based Access:** Only authorized stakeholders can update records.

Blockchain Benefits:

- **Transparency:** Every transaction is visible and immutable.
- **Security:** Cryptographic verification prevents tampering.
- **Efficiency:** Reduces paperwork and delays in the diamond trade.
- **Decentralization:** Eliminates the need for intermediaries.

7. Challenges

- **Sub-Diamond Tracking:** A single rough diamond can be cut into multiple smaller diamonds, making it challenging to maintain traceability across all fragments.
- **Data Storage:** Large image files, certificates, and metadata handling.
- **Scalability:** Handling a global supply chain with millions of transactions.
- **Adoption Resistance:** Traditional stakeholders hesitant to switch to blockchain.
- **Smart Contract Constraints:** Implementing complex verification mechanisms while keeping gas fees low.

7. Future Work

- **Expansion of Traceability Features:** Enhancing the current implementation by integrating more detailed ownership history at each level.
- **Owner-Specific Detail Forms:** Developing a structured form for each entity to input relevant details, ensuring more comprehensive data storage and verification.
- **Advanced Sub-Diamond Tracking:** Implementing AI-powered algorithms to link smaller diamonds to their original rough diamonds and ensure traceability even after cutting.
- **Integration with IoT Devices:** Smart tags for real-time tracking and monitoring.
- **AI for Fraud Detection:** Identifying anomalies in diamond transactions.

8. References

- Research papers and industry reports on blockchain in supply chain.
- Case studies of existing blockchain-based diamond tracking systems.
- Ethereum & Hyperledger documentation for smart contract implementation.

Presentation Script – Enhanced for Impact & Engagement

Introduction

"Good morning/afternoon everyone. Today, I will present my minor project on using Blockchain for Supply Chain Management in the Diamond Industry to ensure Traceability and Authenticity."

Why is this important?

- The diamond industry faces **major challenges**—fraud, unethical sourcing, and counterfeit diamonds.
 - Traditional supply chains **lack transparency** and are vulnerable to manipulation.
 - **Blockchain offers a revolutionary solution**—a **decentralized, tamper-proof ledger** ensuring security and trust.
 - My project aims to **integrate blockchain** into the diamond supply chain for **authenticity, traceability, and fraud prevention**.
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Research Objective

- **Ensure diamond traceability** at every stage—from mining to the end user.
- **Eliminate fraud** and support ethical sourcing.
- **Securely store and verify** ownership, weight, certification, and transaction history on the blockchain.

Why Blockchain?

- ◆ It is **immutable** (cannot be changed or tampered with).
 - ◆ It is **transparent** (anyone can verify transactions).
 - ◆ It is **decentralized** (no single authority controls it).
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Literature Review – What's Already Done?

Traditional Supply Chains:

- **Centralized, inefficient, and prone to fraud.**
- **Paper-based records can be manipulated.**
- **Difficult to verify a diamond's origin.**

Existing Blockchain Applications:

- Successfully used in **food, pharmaceuticals, and luxury goods**.
- **Smart contracts automate transactions** and remove intermediaries.
- **Challenges remain**—scalability, cost, and adoption.

Blockchain for Diamonds:

- Projects like **Everledger & De Beers' Tracr** show progress.
 - But a **fully decentralized, universally accepted solution is still missing.**
-

Research Gap – What's Missing?

- ✗ **No single, unified blockchain framework** covers **all** supply chain stakeholders.
 - ✗ Existing solutions provide **partial traceability**, not **end-to-end tracking**.
 - ✗ Scalability, storage costs, and adoption remain key barriers.
-

Research Contribution – What I am Bringing?

Blockchain-Based Model for full **diamond traceability**.

- Ensuring **each transaction** is permanently recorded.
- Enabling seamless tracking **from mining to retail**.

Smart Contracts for Authentication at every supply chain stage.

- Automating **verification processes** to reduce human errors.
- **Only authorized entities** can modify records.

Tamper-Proof Transactions using cryptographic security.

- **Immutable** storage ensures fraud-proof records.
 - Enables **instant verification** of a diamond's history.
-

Proposed Framework – How Does It Work?

Stakeholders in the Supply Chain:

 Miner → Rough Trader → Diamond Cutter → Diamond Polisher → Diamond Trader → Manufacturer → Wholesaler → Retailer → End User

Authentication at Each Level:

- ◆ Every entity must **verify the previous entity's details** before adding new information.

Data Stored at Each Stage:

- **Miner:** Registers **Diamond ID, Weight, Image, Location**.
- **Rough Trader & Others:** Verify & update details (**cutting, polishing, certification**).
- **Retailer & End User:** Final sale & ownership transfer.

Verification Process:

- ✓ Each stage is recorded on blockchain, making it tamper-proof.
 - ✓ If any inconsistency is found, the transaction is flagged & investigated.
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Implementation – How I Built It?

Technology Stack:

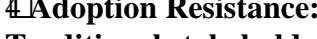
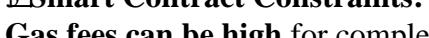
-  **Frontend:** Vue.js for UI
-  **Backend:** Node.js + Express.js
-  **Blockchain:** Ethereum (Smart Contracts in Solidity)
-  **Database:** IPFS (Images), MongoDB (Metadata)
-  **Tools:** MetaMask, Truffle/Hardhat, Ganache for local testing

Smart Contract Features:

-  **Register Diamond** – Miner records initial details.
 -  **Transfer Ownership** – Secure updates at every supply chain stage.
 -  **Verify Diamond** – Anyone can check history **instantly**.
 -  **Role-Based Access** – Only verified stakeholders can modify data.
-

Challenges – What Problems I Faced?

Sub-Diamond Tracking:

- A rough diamond can be cut into **multiple smaller diamonds**, making tracking difficult.
 -  **Data Storage:**
 - **High storage cost** for large images & certification files on blockchain.
- Millions of transactions must be processed efficiently.
 -  **Scalability:**
 - Millions of transactions must be processed efficiently.
- Traditional stakeholders hesitate to adopt blockchain.
 -  **Adoption Resistance:**
 - Traditional stakeholders hesitate to adopt blockchain.
- Gas fees can be high for complex verification logic.
 -  **Smart Contract Constraints:**
 - Gas fees can be high for complex verification logic.

Future Work – How Will I Improve It?

AI-Based Sub-Diamond Tracking:

- Link smaller diamonds to their original rough diamond for better traceability.
 -  **Optimized Data Storage:**
 - Use Filecoin/IPFS for efficient metadata storage.
- Use Filecoin/IPFS for efficient metadata storage.
 -  **Scalable Blockchain Solutions:**
 - Explore Layer-2 solutions (Polygon, Rollups) to reduce costs.
- Explore Layer-2 solutions (Polygon, Rollups) to reduce costs.
 -  **AI for Fraud Detection:**

- **Detect anomalies** in transaction history & flag fraudulent activities.
- 💡 **Encouraging Industry Adoption:**
- Develop **incentives** for businesses to switch to blockchain.
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Conclusion – Final Thoughts

*"In summary, this project brings blockchain into the diamond industry to ensure full traceability and authenticity. By leveraging smart contracts, decentralized storage, and cryptographic security, we create a **fraud-resistant and transparent supply chain**. Future improvements will focus on **AI-driven tracking, scalable storage, and encouraging adoption** to make this system more effective."*

"Thank you for your time! I am happy to take any questions."