COV 882 : Assignment 2

Blockchain system for Wine Industry

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The Wine Industry

Wine is a high value product and involves complicated combination of processes. The taste and quality of Wine is greatly influenced by grape variety and its terroir, encompassing factors like climate, soil composition, and elevation. The weather conditions during the growing season play a critical role, affecting grape ripening, acidity, and sugar levels. Winemaking techniques, including fermentation, aging, and oak barrel usage, further shape a wine's flavor profile and complexity. Additionally, the expertise of the winemaker, along with decisions regarding harvesting time and vinification methods, significantly impact the final product. Storage conditions post-bottling, such as temperature and humidity, also influence a wine's development over time.

Lack of Trust in Value Chain

The wine industry faces multi-level internal trust issues. First, some people make fake wine and put the wrong labels on it, which makes it hard for customers to know if they're getting the real deal or something not as good. Also, the quality of wine can vary a lot depending on where it's made and who made it, so it's tough to know if you're getting a good wine or not. On top of that, it's hard to know where the wine comes from and how much it really costs because the people who sell it don't always tell the truth. Sometimes, they even mix in cheaper grapes or other stuff to make the wine seem better than it really is. Even though they're trying to make rules and certifications to fix these problems, it's still a big challenge to make everyone trust each other in the wine industry.

Stakeholders in Wine Industry

The main process in Wine Production are as follows :-

- Grape production
- Wine Production
- Wine Ageing
- Bottling
- Distribution

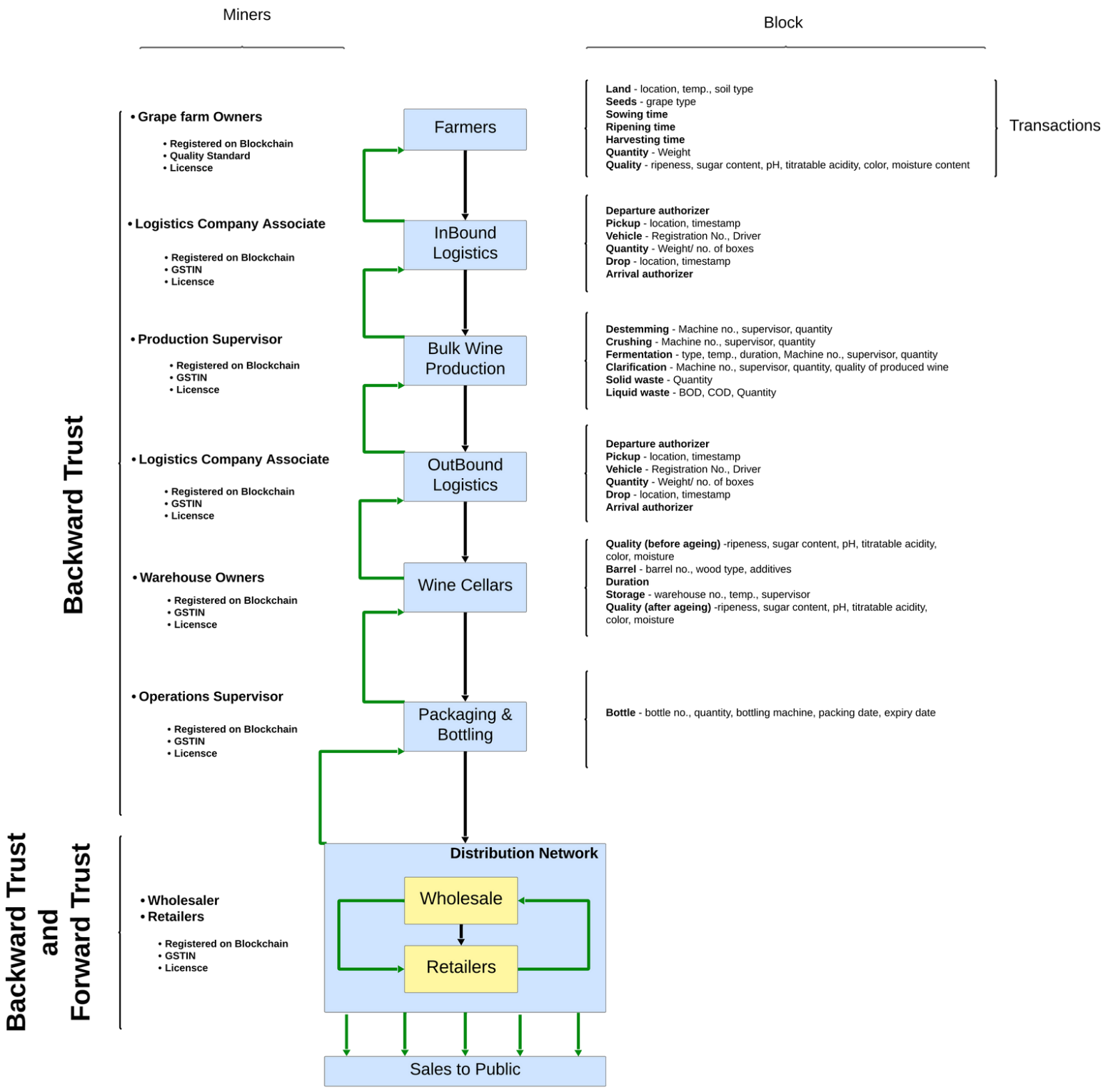
The main stakeholders in Wine Industry are as follows :-

- Farmers
- In-Bound Logistics
- Bulk Wine Production
- Out-Bound Logistics
- Wine Cellars
- Packaging and Bottling
- Distribution Network
  - Wholesale
  - Retailers

Sub-processes in Wine Production supply chain :-

- **Farmers**
  - Land - location, temp., soil type
  - Seeds - grape type
  - Sowing time
  - Ripening time
  - Harvesting time
  - Quantity - Weight
  - Quality - ripeness, sugar content, pH, titratable acidity, color, moisture content
- **In-Bound Logistics**
  - Departure authorizer
  - Pickup - location, timestamp
  - Vehicle - Registration No., Driver
  - Quantity - Weight/ no. of boxes
  - Drop - location, timestamp
  - Arrival authorizer
- **Bulk Wine Production**
  - Destemming - Machine no., supervisor, quantity
  - Crushing - Machine no., supervisor, quantity
  - Fermentation - type, temp., duration, Machine no., supervisor, quantity
  - Clarification - Machine no., supervisor, quantity, quality of produced wine
  - Solid waste - Quantity
  - Liquid waste - BOD, COD, Quantity
- **Out-Bound Logistics**
  - Departure authorizer
  - Pickup - location, timestamp
  - Vehicle - Registration No., Driver
  - Quantity - Weight/ no. of boxes
  - Drop - location, timestamp
  - Arrival authorizer
- **Wine Cellars**
  - Quality (before ageing) -ripeness, sugar content, pH, titratable acidity, color, moisture
  - Barrel - barrel no., wood type, additives
  - Duration
  - Storage - warehouse no., temp., supervisor
  - Quality (after ageing) -ripeness, sugar content, pH, titratable acidity, color, moisture
- **Packaging and Bottling**
  - Bottle - bottle no., quantity, bottling machine, packing date, expiry date
- **Distribution Network**
  - Wholesale
  - Retailers

Wine Industry Blockchain in supplychain



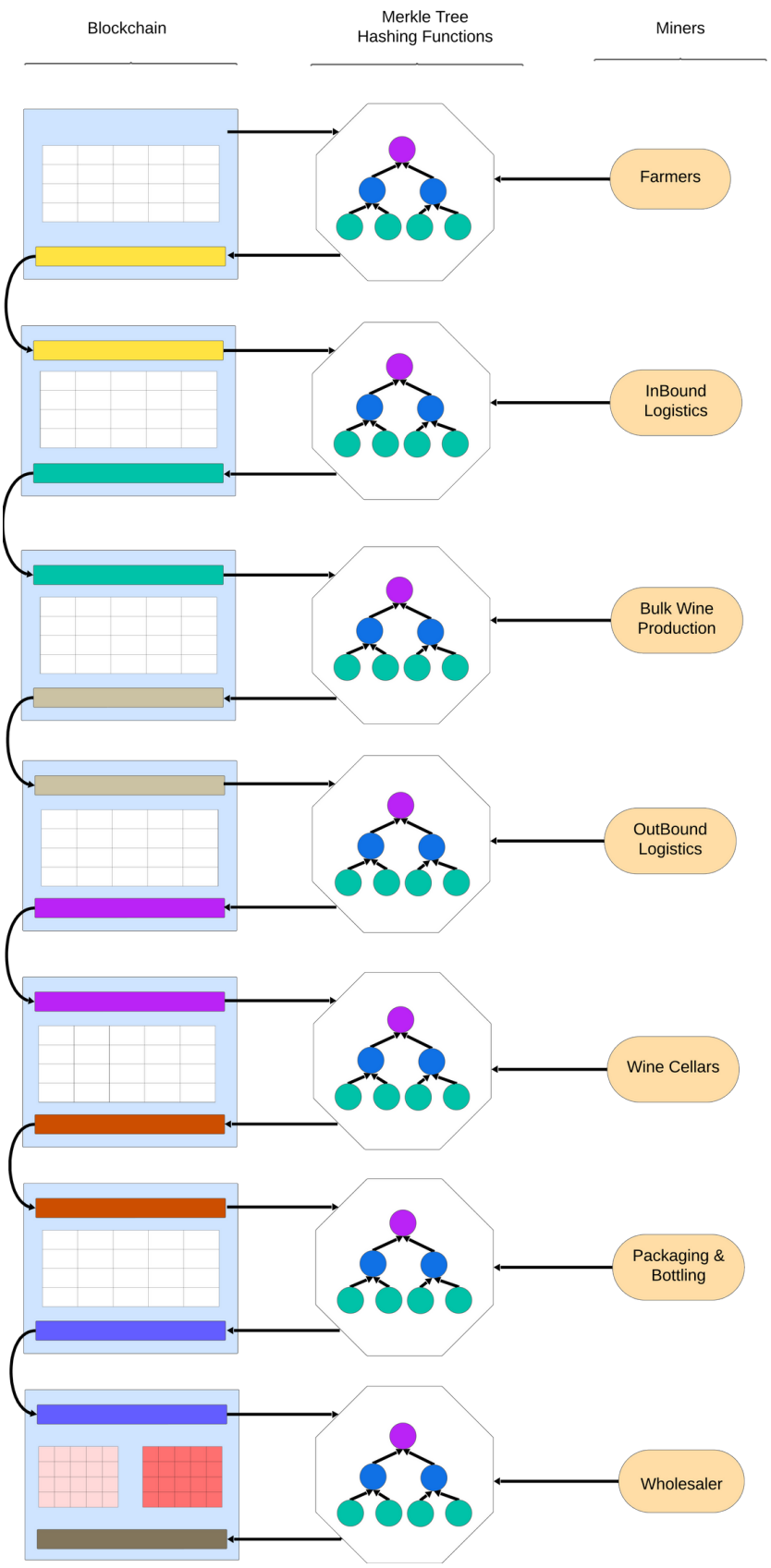
Integrating Blockchain into Supply Chain

For our wine industry blockchain implementation we have used backward trust blockchain and for added security we have used backward as well as forward trust in the distribution network that is wholesalers and retailers.

The block can be mined by only the one authorized on network the main network protocol to be able to become a part of network and a miner are as follows :-

- Must maintain a Government License for business
- Must have a GSTIN number
- Must have a Digital sign

Our network is design to end at retailer, who needs to keep the record of bottle use and submit it to the wholesaler. The wholesaler is the last member in our supply chain that has miner rights in our blockchain.



Hashing and Authentication

All the network participants have a unique ID and all products would have a unique identifier that could be either batch number or bottle number or as such.

The **new hash** would be calculated as a
= previous hash + block ledger + miner ID

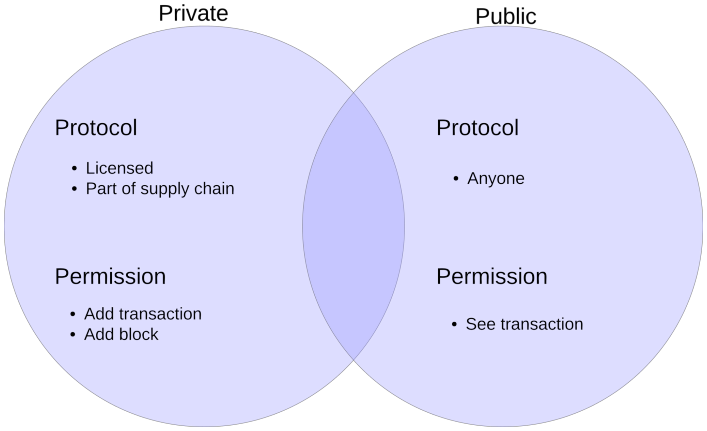
here miner ID is important as there will be multiple farmers, logistics, factories. Thus who is authenticating the transaction is important to maintain transparency and accountability. Also as the supply chain may locally converge or diverge, unique ID or miner helps us understand who will initiate the next phase of processes. For calculation of hash from data we have used merkle tree.

Blockchain Architecture

After understanding the fundamentals of wine industry such as :-

- Wine is a consumer sales business hence consumer loyalty and brand is important
- Wine is a perishable product and it's quality is highly important as well as ever-changing due to ageing even after bottling
- Wine is a regulated industry hence certain guidelines need to be met in order to function

Based on these dynamics the most appropriate architecture will be of **consortium blockchain**, here the general public would have permission to see and verify quality and the permission to edit would remain with the private member that comprises of farmer, manufacturers and other licensed participants of supply chain.



Summary

In a backward trust blockchain system within a consortium blockchain architecture for the wine industry, the mechanism focuses on establishing trust among participants by verifying historical data and ensuring transparency in the supply chain.

Participant Onboarding: Initially, all participants in the consortium, including wineries, distributors, retailers, and regulatory bodies, are onboarded onto the blockchain network. Each participant is authenticated and granted appropriate access permissions based on their role in the supply chain.

Data Recording and Traceability: Every stage of the wine production and distribution process is recorded on the blockchain, from grape cultivation to bottling, packaging, and retail. Each transaction is timestamped and linked to previous transactions, creating an immutable record of the product's journey.

Backward Verification: To establish backward trust, participants can verify the authenticity and provenance of wine products by tracing them back through the blockchain. By accessing historical data recorded on the blockchain, stakeholders can verify details such as vineyard location, grape variety, production methods, and quality certifications.

Regulations and Compliance: Smart contracts are used to enforce compliance with regulations and agreements throughout the supply chain. For example, smart contracts can automate tasks such as verifying the authenticity of organic certification or ensuring compliance with geographical indication regulations.

Data Integrity and Consensus: Consensus mechanisms ensure that all participants in the consortium agree on the validity of transactions and the state of the blockchain. By reaching consensus, participants can trust the integrity of the data recorded on the blockchain and rely on it for decision-making. For our network we have consensus of 51%

Transparency and Accountability: The transparent nature of the blockchain ensures that all participants have visibility into the entire supply chain, fostering accountability and discouraging fraudulent activities. Any discrepancies or inconsistencies can be identified and addressed in real-time, promoting trust among participants.

Computation power: The participants provides computational capabilities to sustain the network this would be shared between wholesalers, distributers, logistics, production as well as farmers.