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## **Executive Summary**

Consumers might have wondered if palm oil products are sustainably sourced. Confirming sustainably sourced products might be difficult for consumers as product information can be difficult to track during the various stages of the supply chain. Furthermore, this information can be tampered with during different processing stages in the supply chain. Using blockchain technology to trace the origin of palm oil products can help consumers make informed decisions and create transparency throughout the palm oil supply chain.

### Problem

Almost every product we use has a high probability of having palm oil as one of its ingredients, which makes palm oil as one of the most consumed vegetable oil, and also a highly controversial ingredient. The annual production of palm oil accounts for about 58.84 million tonnes, with Indonesia and Malaysia contribution for 85 per cent of total produce (Eco-Business, 2017). The demand for palm oil is always increasing as it produces much more oil per area in comparison to other vegetable oils. This increased demand comes at a cost, not only monetary, but in terms of human rights violations, child labour, modern day slavery, extinction of wildlife, and likely possible adulteration (Conflict Palm Oil. (n.d.)).

As of today, Roundtable on Sustainable Palm Oil (RSPO), a not-for-profit organization certifies sustainable palm oil companies which comply to a set of environmental and social criteria, but there's no way for consumers to know if it is RSPO certified and/or sustainable. We propose blockchain as a solution to cater to traceability of sustainable palm oil, adding transparency to the supply chain, creating value to stakeholders, and empowering consumers to make informed decisions.

### Solution

Blockchain technology will provide a tamper proof way of keeping records during various stages of the sustainable palm oil supply chain, starting from farms to retail outlets. It will enable tracking and managing the origin, intermediary processes, logistics, manufacturing, and distribution, which would result in enhanced consumer trust. We would be using a combination of IoT and blockchain technology to achieve a cost-effective and efficient solution. IoT layered with sensors and mobile devices/electronics will provide crop quality, temperature, storage and distribution information. The blockchain layer will keep all information intact from one stage to another in the entire supply chain.

### Consortium

Since there are multiple stakeholders in the palm oil supply chain, the information can be lost or tampered with along the various channels in the supply chain. The proposed solution which is heavy on technology and involves various participants – a consortium blockchain with controlled user groups of palm oil companies will provide a trusted consensus as multiple palm oil

companies will have a stake in the outcome. It will facilitate a shared build, cost, and time, leading to build a faster and cost-effective solution. Even smaller players in the industries can join the consortium solution to reap the benefits of blockchain technology and IoT sensors.

## Hyperledger Sawtooth

Hyperledger Sawtooth being an enterprise solution suits the needs of a consortium for a sustainable palm oil supply chain. A private permissioned Hyperledger Sawtooth would add more credibility with chaincodes (smart contracts) enabling consortia to have restricted control over the network. Multi-language support feature will provide flexibility around infrastructure in terms of software languages, where different organizations can adopt Python, JavaScript, Rust, C++, and Go to develop chaincodes. It will facilitate an easily changeable consensus algorithm without impacting the blockchain network. Additionally, there would not be much dependency between various blocks, adding more flexibility when making changes at a local level. Companies and consortia can make policy decisions that support their business needs. This would lead to a decrease in the scope of errors, enhance simplified implementation, and maintenance of the network. With a high demand and volume of palm oil transactions between various channels in the supply chain, parallel scheduling will increase productivity and performance.

### Proof of Elapsed Time (PoET)

PoET consensus mechanism will provide a fair chance to all the players in the consortia, irrespective of their size and power, to become the block leader and produce a new block. Randomized timer systems for the players in consortia will ensure more efficiency by removing the need for intensive mining. The random selection will mitigate the risks of any bad players from producing the block. Additional security measures can be implemented such as watching for a specific node winning the lotteries frequently or having shorter timers where it reflects that there is a consistent pattern.

## Key players

Our key players are farmers, plantation owners, oil mill owners, refinery owners, retailers, and consumers. Permissioned participants will have access to either write or read the transaction information. The communication between various processes in a sustainable palm oil supply chain and blockchain will be facilitated by a digital layer. The consumers will be able to scan the QR code on their mobile devices and get all the information required to ensure sustainability and they will be able to trace the palm oil origins.

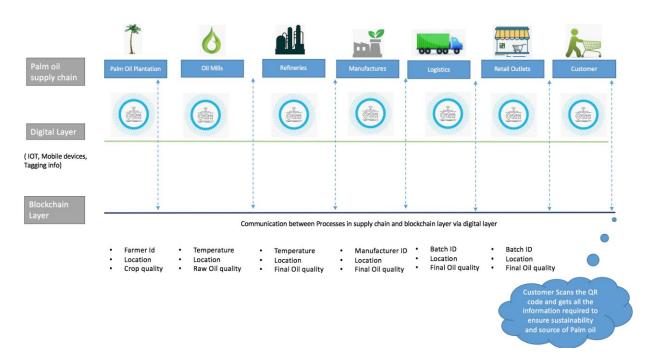


Fig 1: Key stakeholders in palm oil supply chain

### On-chain and off-chain

To enhance performance and scalability of our suggested solution, we will be managing data by using off-chain as a storage mechanism. This will ensure more security as data will not be publicly accessible and it can bring huge value as it is not limited by transaction delays that are part of on-chain transactions.

	Farmers	Palm oil mill owners	Refinery owners	Manufacturers	Retailers	Customers
Farmers and Crop information	<b>✓</b>	<b>✓</b>	<b>√</b>	√X	<b>√</b>	<b>√</b>
Mill Information		<b>√</b>	<b>√</b>	✓ X		
Refinery Information			✓	✓ X		
Final Product Information	<b>√</b>	<b>✓</b>	<b>√</b>	✓ X	<b>√</b>	<b>✓</b>
Logistics Information	<b>✓</b>	<b>√</b>	<b>√</b>	✓ X	<b>√</b>	<b>✓</b>
Retailer Information	<b>✓</b>	<b>√</b>	<b>√</b>	✓ X	<b>√</b>	<b>√</b>
Customers(Read only)	✓	✓	✓	✓	✓	<b>√</b>

<sup>✓=</sup> Access to data

X = Chaincode (Smart Contracts)

Fig 2: Access to off chain data storage on the blockchain solution

## Generating revenue

The consortia would be bearing the cost of implementation for promoting sustainable palm oil solution for an initial five-year duration. Farmers and small key players can join the network for free and later they can pay a minimal renewal fee set by the consortia. This duration will enable small players to cultivate the benefits of more sales, yielding better crop quality, and ensuring environmental ways of producing crops. Consumers will be able to donate voluntary funds to the farmers by tracking the origin of the crops, which would empower farmers economically and socially. Retailers can engage consumers in promoting the sale of sustainably sourced palm oil products.

#### Potential risks

Having talked about the potential of blockchain empowered sustainable palm oil supply chain, there are a few risks which must be taken into consideration before implementing the solution. Since it is a diverse and multi-faceted supply chain which could spread across different countries, it could lead to different regulation challenges making it more difficult or time consuming to implement. Adoption of blockchain technology could be another challenge by small key players due to lack of trust or awareness of the technology. Educating stakeholders can be time and effort consuming which could potentially delay the solution from reaching the markets.

## Existing competition in the market

RSPO certifies sustainable palm oil companies. As of today, 19% of palm oil is globally certified by the RSPO (RSPO. (n.d.)). There is still a bigger chunk of palm oil which goes uncategorized. Our blockchain solution can help fill the gap by onboarding small and big players in the industry and at the same time, ensuring that it is sustainably sourced. Recently there have been some investigations to evaluate the effectiveness of RSPO's in achieving sustainability goals, but lack of insufficient evidence led to questioning its credibility. With our blockchain based solution, tamper-proof data can always be used for auditing and enforce consumer's faith in sustainably sourced palm oil products.

### Conclusion

Tracing the origin of products has been one of the most talked about use cases for blockchain technology (Supply Chain Management. (n.d.)). As part of our suggested solution, we [the consortia] have huge faith in the potential of blockchain technology to track sustainably sourced palm oil throughout the entire supply chain. As of today, customers pay for sustainable palm oil products, but they do not have any insights whether or not the product is sustainable. Capturing the information right from the farms to the retail outlets, will add transparency to the palm oil ecosystem. Since this information would be tamper-proof, there would be no road blocks in gaining trust of consumers and other stakeholders involved in the supply chain. Efforts on technology adoption and educating consumers on sustainability can help us leverage the potential of this solution to the maximum.

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