Improving Provenance Transparency with IOTA

Executive Summary

Distributed Ledger Technologies can aid micro and small enterprise supply chain transparency

This case study focuses on a project deployed by CBC Member Blocks and Mortar Limited in the retail industry. The findings and lessons are easily applicable to the construction industry. They are particularly relevant given that supply chain visibility has been highlighted by the World Economic Forum as a key factor in firms' resilience during the COVID-19 economic crisis **(Liao and Fan, 2020)**.

The project was deployed for a retail e-commerce startup called Revolution of Forms **(Revolution of Forms, 2020)**. The project successfully deployed a provenance tracking application built on IOTA public Tangle for recording product selling on the Revolution of Forms website. Customers of the site are able to view the provenance data directly on the IOTA Tangle via a web explorer to verify the provenance of the items they purchase. The benefits, outcomes and further recommendations (sections 4 and 5) could also apply to distributed ledger systems for tracking provenance of equipment or materials for construction projects.

Project Participants

Foreword

The Construction Blockchain Consortium (CBC) supports knowledge transfer, arranges commercial and academic presentation, assesses and tests commercial services and technology, conducts research, and drives policy, regulation and understanding of the radical consequences of technology and services. Where required we also develop proprietary technology and services for the consortium members; using both outside contractors, and leveraging PhD and Masters students. You can find more about the CBC value proposition and strategy by reading our [open letter].

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Stephen brings extensive experience in Information Management, Innovation Implementation and Building Information Modelling from working on a number of world class international projects including Crossrail, High Speed 1, Cingular 3G Wireless (USA), Zayed Port (Abu Dhabi) and Tengiz (Kazakhstan). He is an active member of the Digital Construction workstream of the Construction Blockchain Consortium (CBC).

1. Business Case Definition

A lack of producer and manufacturer transparency presents an opportunity for distributed ledger technologies (DLTs) to provide solutions

> **"Now, in the hyper-connected and ever evolving world, transparency is the new power."**
>
> *Benjamin Herzberg, Program Lead*
> *Private Sector Engagement for Good Governance at the World Bank Institute*

The market for artisanal handmade craft is flooded with imitations and forgeries. This is partially caused by the lack of a robust system in place for tracking provenance of products or materials. This leads to genuine designers and artisans being unfairly compensated for their expertise and hard work. This can be devastating for large brands that see their profit margins shrink and their brand devalued. It is arguably felt more acutely by individual artisans and boutique designers that rely upon income from their trade for basic subsistence. Furthermore, the black markets for imitation and substandard products are causing the traditional artisan trades to die off; artisans using traditional techniques that are more labour intensive - and thus take longer -struggle to compete against imitation products which customers perceive to be comparable.

There is a growing desire amongst consumers and governments demanding more transparency from producers and manufacturers. The market for products of proven origin is growing as consumers become more conscious about issues relating to sustainability and labour conditions. Distributed ledger technologies provide a technology solution to help with provenance and transparency.

2. Application Challenge

How can provenance be assured via an immutable shared record?

Provenance enables every physical product to come with a digital record that proves authenticity (is this product what it claims to be?) and origin (where was it made?) This creates an auditable supply chain record of the journey behind physical products and potentially the materials used to make those products (e.g. precious metals within a mobile phone).

You can think of a blockchain as a shared digital record that is not controlled by any individual party. All parties hold a copy of this digital record. If anyone wanted to maliciously alter the record, for example by updating where a product was made from Mexico to China, then the other parties holding the correct version of the record would notice and would prevent the update from being made. This important property of blockchains is known as *immutability*. This is very powerful because, as long as the information being entered into the blockchain record is trusted to be correct (see section 4), users can then trust that the information cannot be maliciously altered. This trust is inherent in the blockchain technology itself; users do not need to trust a third-party institution (e.g. a bank or insurance company).

The fact that blockchain records can be trusted without the need for costly third-party institutions makes them very appealing for storing provenance information, particularly where the information is being recorded by multiple parties and/or

across national boundaries. It provides an independent trust platform or, as Michael Casey coined it, a Truth Machine **(MIT Digital Currency Initiative, 2018)**.

One of the main industries that blockchain has started to revolutionise is the supply chain industry. IBM has developed a blockchain network for improving transparency for food supply. LVMH and Microsoft have developed a blockchain platform that serves the luxury clothing industry. These examples involve the use of blockchain to improve transparency of the supply chains used in producing food and luxury items. For this case study the same approach was applied to improve transparency and fairness of the artisanal craft industry.

3. Solution Proposition

IOTA Tangle was used as it is a transparent, end user-friendly application

The solution built for tracking transparency of supply chain for artisanal products used the IOTA Tangle (IOTA, 2020a). This is a reengineered distributed ledger technology which enables secure exchange of both value and data, without any fees. The IOTA Tangle is not a blockchain but rather a directed acyclic graph (DAG). It does not work on the notion of a single linear blockchain (one block being verified by the next block, followed by the next block and so on) but rather a network of nodes which can all transmit and verify transactions to neighbouring nodes.

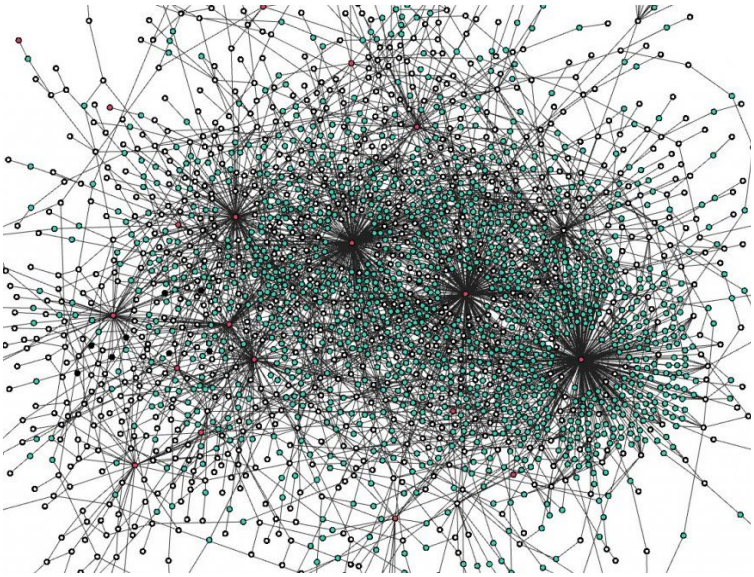

Image 1 - Graphical representation of IOTA Tangle Testnet nodes (2018)

For this project the public IOTA Tangle was used to record each product order that was placed with an artisan designer by Revolution of Forms. All of the records are time stamped and a link is provided in the Product Details section of every product sold on the Revolution of Forms website in order for the customers to check the provenance information easily at their convenience.

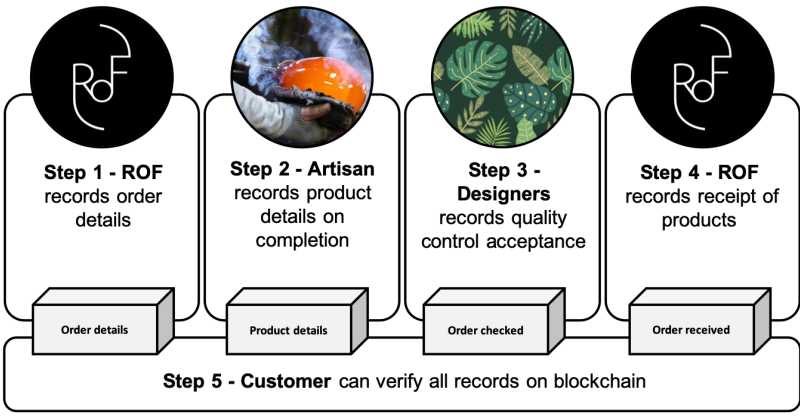

Figure 1 - IOTA Tangle Provenance Solution Overview

An overview of the main steps involved in the blockchain provenance solution is shown in Figure 1 above.

A web-based application (app) was developed in which all of the provenance information in Steps 1 to 4 was entered. This Provenance Record Entry Form app automatically stores the information onto the IOTA Blockchain via open source JavaScript libraries provided by the IOTA community (see figure 2).

Figure 2 - IOTA Tangle Provenance Record Entry Form

The following details are being recorded on the blockchain for each order (Steps 1 to 4 are shown in Figure 3 below):

- **Step 1** – The details of an order placed with a Designer is recorded by Revolution of Forms. This initiates a separate blockchain order "Stream" (formally known in IOTA as a MAM Channel).
- **Step 2** – The Designer will then commission artisans to work on each product for an order. When the products are completed the Artisans will record the product details within the relevant blockchain order "Stream".
- **Step 3 –** Once the Designer has received all of the products on an order from each Artisan, they verify that the order has been finalised.
- **Step 4** – Finally, once Revolution of Forms receives the order this is then recorded in the relevant blockchain order "Stream".

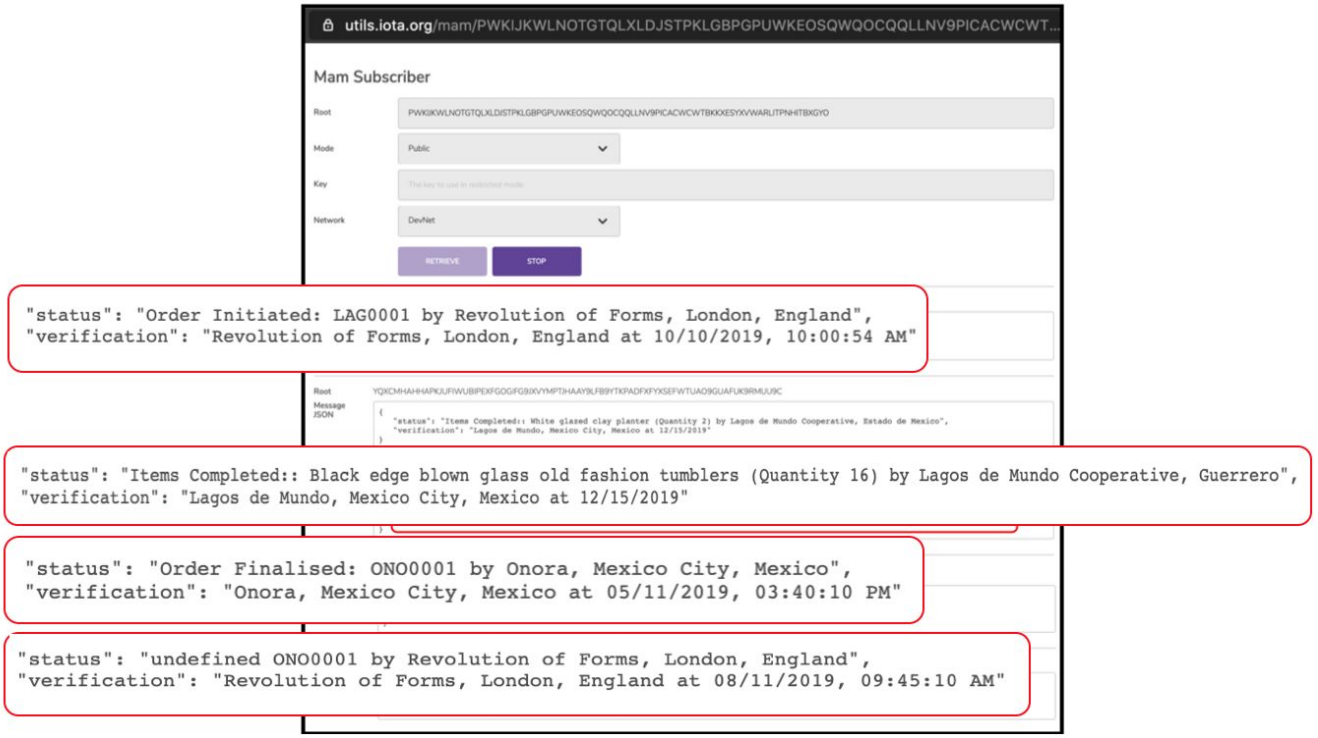

Figure 3 – IOTA Tangle Explorer displaying example order records (record data magnified to ease viewing)

- **Step 5** – A customer can then view the records on the blockchain by accessing the unique ID for the blockchain order "stream". This link can be accessed from the Product Details section of each product page on the Revolution of Forms website (as shown in Figure 4). When a customer clicks on the link they are automatically taken to the blockchain explorer (as shown in Figure 3 above) so they can verify the records.

As an example, our initial order record for Onora can be seen on the IOTA Tangle Explorer here: https://bit.ly/34TWSNc.

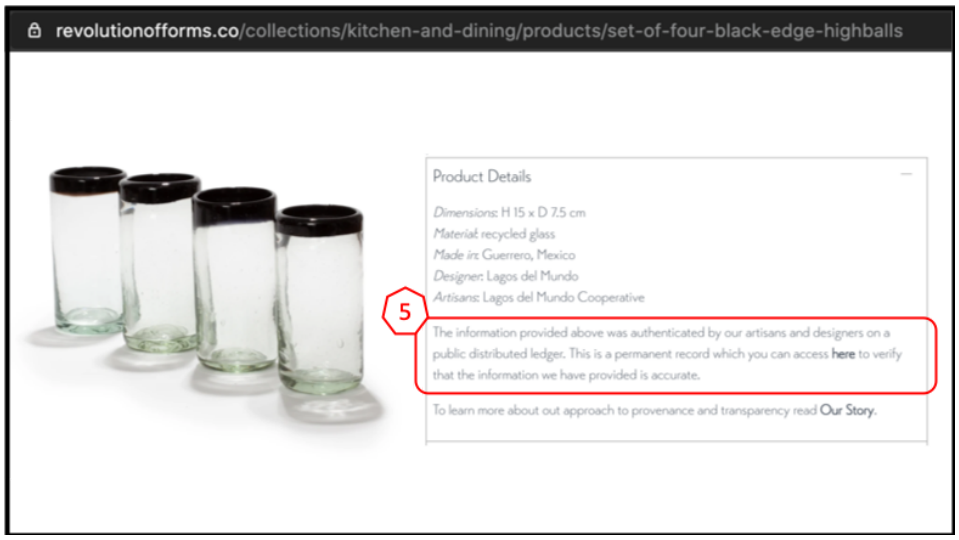

Figure 4 – Revolution of Forms website Product Page (with link to IOTA blockchain explorer)

4. Analysis & Outcomes

The first release of our IOTA provenance application successfully recorded details of all of the products sold by Revolution of Forms on a publicly accessible IOTA tangle. The case study showed how records can be recorded onto the public IOTA tangle through a web application using open source JavaScript libraries. We also were successfully able to retrieve the live provenance information from the IOTA tangle via the IOTA Tangle Explorer **(IOTA, 2020b)**.

UX (User Experience) Issues

As this was the first release of the product we faced challenges training the artisans and brands in Mexico to be able to complete the necessary provenance information via the IOTA Provenance Record Entry Form (figure 2).

Level of trust of the Information

Data recorded on a blockchain (or Tangle in this case) is immutable so cannot be altered, however what is to say that the data being stored in the first place is accurate, complete or correct? This is a known problem in IT called Garbage In, Garbage Out and it is an even greater challenge with Blockchains because the data is immutable. To be able to trust the data on the blockchain users need to be able to trust the source of the data. For this project the source data to be trusted is the provenance data entered into the Provenance Record Entry Form (Figure 2). This application is where each of the parties involved enters the provenance details, e.g. which orders are placed, which items are produced by which artisans, and who has verified the orders are completed.

For this project, data entry worked on a very simple principle. Each party entering information into the application does so through their own unique web page, a process which acts as a crude unique username and password. You can therefore trust that the information on the blockchain was entered by that party in the same way that you can trust that an email has

been sent by someone who controls the sending email account. The problem is that this method is not secure, and the system could be cheated in a number of ways. Indeed, there could be a financial incentive to cheat the system, such as by claiming that an item was handmade and charging a premium when it is in fact mass-produced at a much cheaper price.

Given its susceptibility to abuse, the two main limitations of this current system are:

- The product could have been produced by someone other than the artisan, but the artisan confirms they produced it by completing the provenance record.
- The artisan could pass on the web page to some other party and then that other party completes the provenance record pretending that it was produced by the stated artisan.

Alternative Blockchain Platforms

This project was undertaken on IOTA Tangle mainly because it is a fee-less distributed ledger technology. This suited the requirements of the customer, who was concerned about the cost of paying transaction fees on an alternative blockchain (e.g. Ethereum), particularly as their business scaled and the number of records needing to be registered grew.

However, it is worth noting that alternative public and private distributed ledger technologies such as Ethereum or Cardano are capable of implementing similar functionality. Furthermore, there are now commercial solutions available which are designed specifically to track provenance of goods by using blockchain together with associated technologies (such as nano technology & intelligent labelling such as NFC). Everledger and Provenance are two such commercial products and they tend to be used for higher priced goods such as artwork, precious gems and luxury goods.

5. Considerations

UX Improvements

Significant effort should be spent on optimising the UX design of the products, particularly if the users are typically less IT literate. The goal should be to minimise the complexity and level of effort required to complete the provenance records - this could be achieved through implementing intelligent labelling (e.g. NFC, RFID) together with a smartphone app that automatically registered mandatory information into the entry form (e.g. the identity of user, location, date/time and product details (potentially from QR codes or RFIDs).

Adding Identity Management to Increase Trust

We could increase confidence that the information is actually being entered by the stated party by introducing a simple smartphone app that confirms identity. The Identity application would hold a set of cryptographic keys that are linked to the artisan through a registration process, similarly to how we prove identity when setting up a banking app on our phones. Verification methods available on the smartphone, such as face or fingerprint recognition could be leveraged.

In addition to improving trust through more secure identity we could also harvest the geolocation data from the phone being used to register the record. This will allow us to verify and record the geographic location where the product record was registered.

The system could of course also be expanded so we can record details of techniques used for the products and also to provide traceability of the raw materials used.

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