AROUND THE WORLD OF IOT

In this column we plan to take a tour around different physical locations in the world with the objective of highlighting the peculiarities of the trendiest IoT-related applications in selected regions. Thus, the "IoT World" will certainly be physical, but traveling around it shall also expose to the readers how different application domains have been addressed, with particular attention to business sustainability.

Brand Protection, Pizzas, and the Case for IoT Traceability

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In this column, we take a journey to Europe and analyze how IoT technology could be used to protect the Made in Italy brand and make it harder for fake products to find their way into the market, therefore protecting consumers from being misled in their purchases. Recent research into what is commonly referred to as the "Italian sounding" phenomenon, estimated its value to be around 100 billion Euro (+70 percent over the past 10 years).[1] One can argue whether or not this number is the actual amount "missing" from the Italian economy or whether it is not also reflecting the fact that the offer of authentic products cannot sustain demand due to lack of enough production or simply lack of adequate distribution channels (i.e. business-driven choices, political-embargos, etc.). When this data, however, is crossed with a reduced percentage of exports year on year, one quickly realizes that the problem is a real one, and it can be easily generalized to other brands, not only for the Made in Italy one. In the era of advanced Information and Communications Technologies (ICT), IoT can certainly help in addressing this traceability problem, especially when coupled with tamper-proof blockchains to ensure wide visibility over entire supply-chain transactions, to detect fraud and to ensure improved accountability in case problems occur.[2]

The value IoT adds certainly lies in the ability to deploy, at reasonably low costs, a wide and distributed monitoring infrastructure, automatically producing data of interest that are then recorded in a tamper-proof ledger.

To better explain and add details to what can be done, given the Italian context in our introduction, what better example to use than a famous recipe? We look at what IoT and blockchains can do to ensure traceability in the making of a *traditional, Made in Italy pizza*. This can be generalized to any production line where the final outcome is the result of using r*aw material from suppliers*, processing it following a *precise set of rules* and delivering it to the customers.

In addition to the standards of quality in our example the *Made in Italy "seal"* could mean a certain control over both suppliers (i.e., ingredients' quality and provenance) and the production process (i.e., adherence to a *traditional Italian* recipe[3]) besides geo-fencing the location of all operations leading to the final product.

The "pizzaiolo" asked to make a *traditional, "Made in Italy"* pizza has to objectively prove that all these aspects were fulfilled. Let's assume in our example that the use of a *traditional* recipe as well as provenance, are indeed value-added differentiators that increase the market value of the pizza, something the customer is willing to pay extra for. The use of IoT and blockchains is no panacea, as we will show, but there is a clear role these technologies can play to help minimize for the customers the risk of not being delivered the additional value (i.e., *traditional* and *Made in Italy*).

The Issue of Trust

Whenever an objective proof is needed, there comes the issue of trust: whom do we trust? Who can provide us with evidence that what we are buying is authentic and has not been tampered with? There are three types of chain of trust one will encounter in such a scenario (and generalizing, in any "raw material + set of processing rules" production line scenarios): 1) 1:1 trust, 2) certified trust, and 3) technology-based trust.

In 1), the chain of trust is populated by actors that know one another well: the pizzaiolo will trust that her suppliers are indeed food producers from Italy and vouch for them to her customers who in turn will also trust the fact that he is able to prepare *traditional Italian* pizzas. This is highly desirable but unfortunately can only be applied in a very limited number of situations with a restricted scope.

In 2), the chain of trust needs to include a third party entity, trusted by all actors because they do not know each other: the pizzaiolo will rely on a third party authority vouching for the fact that her suppliers are indeed food producers from Italy. Our pizza maker will also need to be certified as able to follow the steps of what makes a recipe traditional and show that all operations leading to the *Made in Italy* final product are indeed made within the boundaries of the specified location.

In 3), the pizzaiolo will entirely rely on technology to prove that the outcome is indeed *traditional* and *Made in Italy*, cutting out the middleman and bringing us back to a more desirable chain of trust of type 1.

All three methods have associated pros and cons and show somehow an evolution that took place for many of the products we use and consume today. Solutions in a small local ecosystem often rely on trust of "type 1." As the ecosystem of producers, suppliers and consumers grows bigger, weakening the direct-trust links between all actors, there comes the need for "type 2" trust, guaranteed by a third-party authority that can certify adherence to a given set of "brand conditions." This solution is quite heavy on overheads, setting an entry threshold that is more related to supporting the procedures any certification authority must have in place to do its job. This is more and more perceived as hindering the thriving of ecosystems created around a given brand. In our leading example, a pizzaiolo must also be good with paperwork, having to invest time in recording all interactions with suppliers who in turn have to prove they are selling Italian products. Moreover, he would have to provide evidence for his ability to realize a *traditional Italian* recipe etc.

The advances of IoT and the availability of many Distributed Ledger Technologies implementations are opening up new application scenarios more aligned with chain of trust of the third type, where third party authorities are removed and where the intrinsic value that generates a reward transaction (i.e. paying for a good pizza) can indeed be enhanced with reduced overheads, although as we anticipated IoT and blockchains are no panacea.

Ensuring Quality and Suitability of Suppliers

Each supplier must have the means to guarantee the quality and origin of his product. IoT is a key player in all this. "Quality" is a result of a well-managed production process where IoT can have a role to play: through its sensing capabilities it provides the means to track the adequacy of environments for processing food supplies, storing them, transporting them, etc.

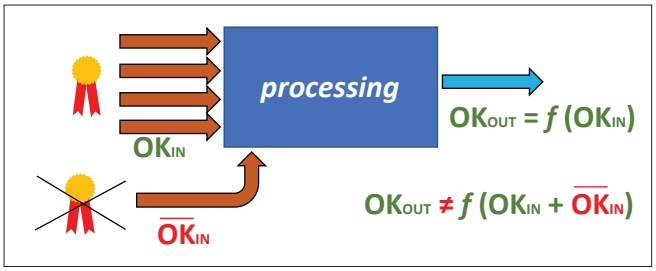

FIGURE 1. Ensuring the suitability of suppliers.

When it comes to "origin," if the maker of the final product can have such a proof of geographical provenance from all his suppliers, this certainly provides a strong means to claim adherence to the requirements of the production rules. Moreover, if one can easily relate the amount of supply products that are needed for a given amount of a final product, then it becomes harder for non-certified products to get into such a protected chain (Fig. 1).

Such a provenance traceability cannot be easily tampered-with once the transactions are indeed recorded in a blockchain. This applies to the case where the recorded data is true as well as when it is false. Unfortunately, blockchains do not add piece-of-mind in this respect if the ICT system does not prevent data from being forged before it enters the blockchain (i.e., between the IoT sensor and the blockchain). What one achieves, however, is an increased risk associated with wrong-doing: transaction footprints are replicated in a non-repudiation manner throughout the blockchain.

Combining IoT with blockchains can potentially create ecosystems that, while not able to guarantee quality and provenance in absolute terms, can certainly discourage non-virtuous behaviors in favour of those ecosystem members willing to adhere to the rules, and willing to provide IoT-based monitoring evidence for it.

The current perception is that technology can add market value to the final product besides providing the means to automate and track production processes, which also has its "bottom-line" advantages as the IBM Food Trust Blockchain shows.[4] The other promising aspect is also that adoption of these traceability solutions does not demand an "all or nothing" approach as there are ways in which traditional solutions (i.e., certificates, or reputation of suppliers) can still be leveraged upon until an objective IoT data source replacement is found.

The Production Rules

If the origin of supplied raw material can be easily tracked (roughly speaking, one IoT tag is all it takes if a data platform already exists), we are still behind with the tracking of adherence to given production rules. Usually behind a quality brand there are strict and well-defined production rules, summarized in the "recipe" to be followed in the process that leads to the final product being delivered to the customer. As in the "quality" tracking here as well, we have rules that regulate the production process and that must be checked for compliance rather than single IoT tags.

Clearly there are far more aspects to consider when ensuring adherence to what a brand usually represents than what technologies can objectively monitor. IoT and blockchains are certainly not the silver bullet here either but can help. As in the quality and provenance case, the data and information recorded in the full production chain is only as good as the trust one can put in each single piece of the final product's quality jigsaw, but the above-mentioned "risk considerations" apply here as well.

What we do see as an undeniable trend, is a more widespread use of IoT, thanks to the increased availability of cheap and tiny sensors and the wide coverage of low-energy LPWAN networks. These are all important pieces in the jigsaw aimed to support virtuous manufacturers in objectively monitoring their production processes, helping them better protect the market value of their products.

Brand Protection and Digital Innovation: An Irreversible Trend?

We have seen why blockchains provide a promising means to protect brands with IoT-driven traceability progressively improving each element of the full production value chain. Providing an immutable source of monitoring information gives peace of mind to the manufacturers and incentivizes virtuous behaviors, knowing that traceability makes it possible to quickly find the culprits and hold accountable whomever did not follow the rules should a problem with the final product arise.

Coming back to the Italian landscape, a recent event organized by an Italian research and innovation watchdog[5] showed how these two digital innovation technologies are percolating into the agri-food sector, with more than a hundred technology solutions already present and many start-ups filling up the demand of the domestic Italian market and ready to expand beyond the Alps.[6]

It may not be in direct response to the Italian Sounding threat, but there is certainly a lot of interest in traceability advantages and solutions. Especially in the agri-food sector, Italy seems to be the ideal playground for validation of these technologies, not only due to the important weight of the Made in Italy brand in the economy but also thanks to high consumer sensitivity to such issues.

To conclude, when it comes to brand protection, while opportunities for cutting corners still remain, we are witnessing an irreversible trend that will give consumers the full knowledge of what they are buying. Good news for traditional, Made in Italy pizza lovers!

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FOOTNOTES

[1] https://www.coldiretti.it/economia/falso-made-italy-sale-100-mld-70-10-anni.
[2] https://www2.deloitte.com/content/dam/Deloitte/lu/Documents/technology/lu-blockchain-internet-things-supply-chain-traceability.pdf.
[3] https://www.pizzanapoletana.org/public/pdf/Disciplinare_AVPN.pdf.
[4] https://www.forbes.com/sites/astanley/2018/10/08/ready-to-rumble-ibm-launches-food-trust-blockchain-for-commercial-use.
[5] https://www.osservatori.net/ww_en.
[6] https://www.osservatori.net/it_it/osservatori/comunicati-stampa/smart-agri-food-boom-agricoltura-4.0.