Using blockchain technology to combat counterfeiting

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Abstract. Although the globalization of trade entails multiple benefits for both traders and consumers, such as the expansion of markets and the possibility of accessing a wide range of products, it also entails the risk of the spread of counterfeit goods. One of the tools that could be used to combat this trend is blockchain technology. The aforementioned technology presupposes the existence of a single ledger that is shared and synchronized across many sites, organizations, or computers, with participants having the ability to register any type of information. Thus, in the near future, a single ledger could be created in which relevant information about the specific traded good, such as its origin or sanitary certificate, would be recorded. By doing so, the quantity of counterfeit goods on the market will decrease, while consumer confidence will increase. The World Intellectual Property Organization is currently analyzing the possibility of incorporating blockchain technology into several areas specific to intellectual property law, with one of the goals being to combat counterfeiting. Therefore, through this article, we propose to conduct an analysis of the legal provisions of the European Union that aim at fighting against counterfeit goods. Simultaneously, we will investigate the methods used by the private sector in this field, particularly blockchain technology. In this regard, some practical examples that have been used for several years by large retailers such as Walmart and Carrefour will be presented.

1. Introduction

One of the most important successes of the European Union is the creation of a single market where products can enter without being hindered by additional barriers. Despite the fact that this phenomenon has many advantages, the prevalence of counterfeit goods coming from both Member States and third countries presents a significant threat.

At the level of the European Union, efforts are being made to put an end to this phenomenon by developing a series of restrictive norms that place additional requirements on companies. However, the desired result seems unlikely to be achieved in the near future. Especially since, as electronic commerce develops, more and more goods from third countries enter the single market, which is beneficial but also risky, because some of these goods violate companies' intellectual property rights.

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Therefore, through this article, we propose to conduct an analysis of the legal provisions of the European Union that aim at fighting against counterfeit goods. Simultaneously, we will investigate the methods used by the private sector in this field, particularly blockchain technology. In this regard, some practical examples that have been used for several years by large retailers such as Walmart and Carrefour will be presented.

2. An analysis of current EU regulations from a theoretical and practical perspective

To begin with, according to Organization for Economic Co-operation and Development (OECD) data on counterfeiting and international trade, *'the total value of counterfeit and pirated goods was about $1 trillion in 2013 and is expected to grow to close to $3 trillion in 2022'* [1]. In this regard, according to the latest figures published by the OECD, *'footwear accounted for 22 percent of the total value of counterfeit goods seized by customs in 2016, making it the most pirated product category, ahead of clothing, leather goods, and electrical equipment'* [2]. Aside from these, pharmaceuticals, toys, perfumes, and watches are among the most counterfeited products, according to the same statistics [2]. As a result, the likelihood of purchasing a counterfeit product at least once in a lifetime is quite high.

According to specialized literature, *'counterfeit goods are those that illegally imitate, copy, or duplicate a good or use a registered trademark without authorization and, therefore, infringe upon the legal right to copy of the right's owner'* [3]. The interpretation of this definition leads to the conclusion that there are two methods of goods counterfeiting.

The first category includes items that only look like the originals. In their case, the manufacturer takes advantage of the buyers' lack of attention, who may believe they are purchasing an original good. However, most buyers are aware that they are purchasing a counterfeit item due to its lower price.

The second category includes goods that claim to be original and use registered trademarks or other types of intellectual property rights without authorization for this purpose. In their case, an ordinary buyer will not be able to recognize that the item he is purchasing is counterfeit because there is an almost perfect visual similarity. However, the buyers will recognize that something is wrong after a short period of time, usually due to the breakdown of the good. Most likely, they will seek compensation from the manufacturer whose brand was used, but their attempt will be unsuccessful because the goods were never made by that manufacturer. As a result, buyers will most likely no longer purchase any products from that particular brand, and the manufacturer will suffer a loss of profit and reputation.

Even if purchasing a counterfeit good usually results in a monetary loss, there are some cases where the outcome can be fatal. For example, *'recent investigation found formaldehyde in woolen and cotton clothes which was 500 times higher than safe levels should be'* [4]. According to World Health Organization *'the formaldehyde is used to give a permanent-press effect to clothes but high levels (20 parts per million) can cause eye, skin and nasal irritation, respiratory problems, asthma and skin cancer'* [4]. More dramatic examples can be found in the case of counterfeit alcohol products. For example, 34 people recently died in Russia after *'consuming counterfeit vodka'* [5].

To combat the spread of counterfeit goods, the European Union has developed several normative acts. Thus, the current legal provisions impose obligations not only on manufacturers but also on other trade participants, such as importers, in relation to the goods they prepare for sale. For example, according to the Proposal for a Regulation of the European Parliament and of the Council on general product safety amending Regulation (EU) No 1025/2012 of the European Parliament and of the Council, and repealing Council Directive 87/357/EEC and Directive 2001/95/EC of the European Parliament and of the Council

(hereinafter, Proposal for a Regulation on general product safety), it is necessary that the goods entering the single market meet the conditions outlined in Article 3, Point 2, which defines the concept of a 'safe product'. According to this legal provision, 'safe product' means *'any product that, under normal or reasonably foreseeable conditions of use or misuse, including the actual duration of use, does not present any risk or only the minimum risks compatible with the product's use, is considered acceptable and consistent with a high level of protection of the health and safety of consumers*'. Relating this legal provision to the previously mentioned example, counterfeit clothes cannot be considered 'safe', as they are dangerous for the health of consumers.

However, these goods could easily fall under the category of 'product presenting a risk' as defined by the provisions of the Regulation (EU) 2019/1020 *on market surveillance and compliance of products* (hereinafter, Regulation 2019/1020). Thus, according to Article 3, point 19, 'the product presenting a risk' *means a product having the potential to affect adversely health and safety of persons in general, health and safety in the workplace, protection of consumers, the environment, public security and other public interests, protected by the applicable Union harmonization legislation, to a degree which goes beyond that considered reasonable and acceptable in relation to its intended purpose or under the normal or reasonably foreseeable conditions of use of the product concerned, including the duration of use and, where applicable, its putting into service, installation and maintenance requirements*. As a result, it is unclear why the European legislator regulated a new concept that brings nothing new to the fight against counterfeiting or other fields. It seems to be a legislative technique to avoid making additional references to previously adopted normative acts.

In addition to these pieces of legislation, the European Union elaborated the Regulation (EU) No. 608/2013, which was created to provide additional protection for both producers and consumers by enforcing intellectual property rights. According to the legal provisions of this regulation if customs officials identify counterfeited goods, they have the option of suspending the release or detaining the goods. In other words, the suspicious goods will be stored in a warehouse while their provenance is investigated. If it is determined that these goods violate another person's intellectual property rights, customs authorities have the authority to destroy them.

For example, the three parallel stripes *'that appear across all Adidas product lines*' are a registered trademark [6]. We could say that the said trademark is one of the most valuable assets owned by the German company. Thus, because Adidas is one of the largest manufacturers of sporting goods, its products are frequently counterfeited. In this regard, according to the data provided by Adidas, *'10% of its current market products may be counterfeit*' [7]. A significant part of this volume is also found on the European Union territory. Considering the enormous volume of production that enters the market under the Adidas brand, it is nearly impossible for supervisory authorities to identify all cases of counterfeiting. However, if some of these goods can be identified, the customs officials can proceed in accordance with the Regulation (EU) No. 608/2013.

According to these legal provisions, one of the primary goals of European Union bodies is to ensure the security of the single market. To put it differently, substantial efforts are being made to reduce the amount of non-compliant goods by implementing preventive mechanisms such as customs control and regulation of new market challenges.

One of these challenges is the expansion of electronic commerce, which has reduced the effectiveness of the Directive 2001/95/EC, which goal is the general safety of products. In this regard, according to the reasons for and objectives of the Proposal for a Regulation on general product safety the application of the directive to all consumer products, *'whether sold in brick-and-mortar stores or online*' jeopardizes *'the safety of EU consumers and the level playing field for compliant EU businesses*'. As a result, there is a risk that products that fall

into the category of risk products, as defined by Regulation (EU) 2019/1020, will be introduced on the single market.

To address these concerns, the Regulation proposal on general product safety was drafted which, if all legal requirements are met, will replace the Directive 2001/95/EC. This proposal establishes a set of safety requirements for economic operators and the goods they put into the market. For example, according to Article 8, point 4 from Regulation proposal on general product safety, manufacturers *must include technical documentation on their products, which must include a general description of the product and its essential properties relevant for assessing the product's safety, as well as an analysis of the possible risks associated with the product and the solutions adopted to eliminate or mitigate such risks, including the results of any tests conducted by the manufacturer or another party*. Furthermore, one of the most important obligations that manufacturers must fulfill is the requirement *to indicate on goods their name, registered trade name, or registered trade mark, as well as the postal and electronic addresses at which they can be contacted, on the product or, if that is not possible, on its packaging or in a document accompanying the product (*Article 8, point 7).

Based on the interpretation of these legal provisions, it follows that this Regulation proposal tends to provide additional protection to consumers who use electronic commerce to obtain a specific good. At the same time, the legal texts' obligations and safety measures apply to goods that are introduced to the market in the traditional manner. However, for a variety of reasons, those provisions will have a limited impact on the fight against counterfeit goods.

First, the documents accompanying the goods may be falsified, which may go undetected due to free trade. As a result, such a safeguard would be effective only for products originating in third countries, and only if the supervisory authorities conducted a thorough examination, which would incur additional costs as well as the involvement of a greater number of human resources.

For example, operation OPSON XI targeting food fraud, was coordinated by Europol for EU-wide actions. It took place between December 2021 and May 2022. According to reports, national authorities conducted *'checks in customs areas, physical and online marketplaces, and throughout the food supply chain to detect criminal activity*' [8]. Despite more than 70,000 checks, only 26,800 tons of counterfeit production were discovered. Therefore, in comparison to the time required to discover these quantities of goods and the number of counterfeit goods that enter the single market on a daily basis, the competent authorities appear to have been outpaced.

Second, the obligation to indicate the trademark or any other intellectual property right on product packaging could only be effective if all trade participants acted in good faith. Because counterfeiting involves illegal actions and, as a result, bad faith on the part of the producers, this protective measure will only be effective in a few cases. For example, *'the simplest, and arguably crudest, way to counterfeit wine is to slap the label of a fine wine on to another, similar-looking bottle*' [9]. From a legal standpoint, there is a trademark on the wine bottle, in most cases an original one, but what matters is that the wine is counterfeit. Therefore, the relevant legal provision may only be effective in rare cases where the intellectual property right itself is falsified. However, the possibilities provided by new technologies may be able to counteract this last point.

In addition to the previously mentioned normative acts, the European Union is attempting to increase consumer trust in the authenticity of the displayed products by making several verification tools available to those who are interested.

Consumers, for example, could use the eSearch plus to access the database of the European Union Intellectual Property Office (EUIPO). They can use this platform to compare the authenticity of a trademark or geographical indication on a product to those listed in public registers platform [10]. However, it would be more of a hypothetical situation because

it would require knowledge that a buyer might not have, as well as access to the platform and the completion of several formalities. As a result, it is unlikely that a consumer would use this tool solely to verify the authenticity of a product. To limit or even eliminate these inconveniences, *'new technologies such as non-fungible tokens (NFT) and blockchain'* could be used [11].

3. The opportunities that blockchain technology provides

The goods are counterfeited for commercial purposes rather than personal use. As a result, the manufacturer or another person who knows that the goods are counterfeit is forced to act like a legitimate trader. This behavior entails locating a market and transporting goods to it. In other words, there are no significant differences in comparison to other legitimate trade participants. Consequently, it is not necessary to draft new normative acts with the sole purpose of establishing new rules to combat counterfeit products. It is critical to capitalize on the new opportunities provided by technology.

For example, one method for combating their activity would be to monitor the entire supply chain, beginning with the manufacturing stage and ending with the sale of the goods. Thus, in order to determine whether a good is authentic, any interested person should be able to identify the date on which it was manufactured, the date on which it was delivered, the date on which it passed customs control, in the case of goods intended for trade in another state, and the date on which it was placed for sale. Even if one could argue that this information is usually displayed on the packaging of the goods, there is no guarantee that it is correct. After all, it is just a piece of paper that anyone with a printer can reproduce.

One of the solutions could be the digitization of the entire supply chain, at least for the most counterfeited items. The digitalization would involve the creation of a web page containing the goods' essential information, such as the date and place of production. However, it is important to note that counterfeit goods producers are evolving, so simple digitization is no longer sufficient. In this regard, it is now common practice to create duplicates of major corporations' websites. The operation entails duplicating a website and selling counterfeit goods on it. Thus, simple digitization of the supply chain could not have a significant impact because it could be easily defrauded by creating a fake site with no exaggerated costs. To minimize these risks, blockchain technology can be implemented.

To better understand what blockchain technology entails, a definition is required. The European Economic and Social Committee defines blockchain technology *'as both a code, i.e., a communication protocol, and a public register, in which all transactions between network participants are recorded one after the other, with a high degree of transparency and in an irreversible manner'* [12]. In doctrine, blockchain technology is defined *'as a distributed, append-only database that enables transactions between human or software agents without the use of a central trusted intermediary'* [13]. The most important thing to remember from these definitions is that *'blockchain is a method of storing data'* [14].

As an illustration, if a product is delivered from the warehouse on November 30, 2022, this information will be recorded in a block and will never be able to be changed. Once the item has arrived at its destination, an additional registration will be made to allow tracking of the duration of the transportation process. What matters is that, compared to classical digitalization, blockchain technology offers a high level of security because the records created through it cannot be changed. This *immutability* is due to a *'combination of factors including the cryptography used in a Blockchain, its consensus/validation mechanism and its distributed nature'* [15].

In addition to immutability, we identify *'interoperability, transparency, traceability, and security as key features of blockchain technology'* relevant to the current work [16].

The IEEE Computer Society defines interoperability as *'the ability of two or more blockchain systems or applications to exchange information and to mutually use the information that has been exchanged* ' [17]. In other words, interoperability can be defined as a blockchain's ability to interact with other blockchains or even with technology that is not part of the distributed ledger network. This feature is critical because the respective technology is constantly evolving and must be able to adapt to market demands. For example, while blockchain technology was initially used only for cryptocurrency trading, *'it is now used in a variety of applications such as digital marketing, entertainment, and finance*' [18]. In terms of the supply chain, the United Nations Economic Commission for Europe believes that interoperability *'should also be understood as a concept that supports the implementation of the principle of free movement of goods and services in the digital world* ' [15].

The First Decentralized Finance Encyclopedia defines blockchain transparency as *'a characteristic feature of the blockchain that ensures all the transactions and data on the network are available to everyone with access to the system*' [19]. According to this definition, anyone with access to blockchain technology will be able to consult the information that interests him without incurring any costs in terms of money or time. Thus, if we return to the theme of this article, i.e., fight against counterfeit products, transparency will enable any interested party to obtain key information about the product they intend to purchase. For all that, it is necessary to develop a method of interaction with buyers or other people who do not have a contractual relationship with the manufacturer in order to facilitate access to this information for them. The least complex option is to assign each selected product a special barcode or QR code that can be scanned by a smartphone.

For example, by scanning a unique QR Code, any consumer will be able to access vital *'information (data on the producer, location, and manufacturing date of the good, as well as information on health certificates) about the product they intend to purchase without having to navigate through multiple platforms*' [20]. This possibility is offered by traceability, which could be defined as the ability to identify and track a good throughout all stages (production, processing, and distribution).

Aside from monitoring the supply chain, blockchain technology can be used to identify cases where manufacturers use slave labor. In this regard, manufacturers can be *'required to prove that they are not using child labor and/or are paying their workers a living wage*' [15]. The relevant evidence should be pre-registered in the blockchain ledger so that it can be verified. Due to a lack of supporting documentation and an inability to quickly falsify it, some of them won't be able to prove this. As a consequence, the demand for their products may decrease.

Coca-Cola Co., for example, imports sugarcane primarily from the Asia-Pacific region. As a result, the business has received a lot of criticism, including claims that it works with suppliers who use slave labor. In this regard, a recent report *'shows that the company is still using suppliers that use slave labor in China's Xinjiang province*' [21]. To respond to these critiques, *'a private-public partnership spearheaded by the Coca-Cola Company (KO) and the United States Department of State will use blockchain technology to combat forced labor in their supply chains*' [22]. Despite the fact that it seems to be a publicity stunt (meaning *something done just to get the attention of the public* [23]), it still has the effect of expanding the use of blockchain technology in supply chain monitoring.

Last but not least, using blockchain technology in addition to what has already been discussed could aid in the realization of the EU's Green Deal [24]. The strategy perspective calls for a number of actions, such as combating global deforestation and forest degradation caused by EU production and consumption. In this regard, the European Commission elaborated the Proposal for a regulation on deforestation-free products. This normative act requires companies *'to prove that the products are both deforestation-free (produced on land that was not subject to deforestation after 31 December 2020) and legal (compliant with all*

relevant applicable laws in force in the country of production)' [25]. Furthermore, *'companies will also be required to collect precise geographical information on the farmland where the commodities that they source have been grown, so that these commodities can be checked for compliance*' [25]. By interpreting this legal provision, it follows that the monitoring process will be carried out by fusing geolocation with remote monitoring via satellite images.

Although it is stated that *'geolocation coordinates are the simplest and most cost-effective way to obtain the necessary geographic information for authorities to be in a position to check whether products and commodities are deforestation-free*' this statement is not entirely accurate [26]. It is unclear how it will be possible to precisely verify the provided data given the enormous amount of wood that is exported. The satellite images can only show that the portion of the forest mentioned in the supporting documents was actually deforested. Therefore, it's possible that some of the trees were cut down in uncontrolled areas.

For example, according to data provided by the European Parliament, 158 million hectares of forest, or 5% of all forest in the world, are found within the EU [27]. A database of the distribution of forests across the European Union's states and regions is also available [28]. However, because the hectares of forests have not been digitized, this information is only statistical data. Consequently, it is essential to build a new database using blockchain technology. Thus, *'through the use of blockchain, this data would be time-stamped and tamper-proof, ensuring EU privacy, data protection and competition rules are fully respected*' [29]. Therefore *'with its enhanced data security and traceability, blockchain can help tackle trust in wood and other natural-resource supply chains to guarantee specific attributes and other relevant identity information*' [29].

4. Blockchain technology implementation at the European Union level. Practical examples

Distributed ledger technology, specifically blockchain technology, has advanced in recent years to the point where it can no longer be ignored by European Union bodies. According to information on the European Commission's official website, the EU aims to *'be a leader in blockchain technology*', attempting to lay the groundwork for a *'gold standard*' that includes European values and ideals [30]. The European Union's strategy for achieving this goal includes *'building a pan-European public services blockchain*, *the foundations of which have already been laid by the creation of the European Blockchain Services Infrastructure*' [31]. This assumes the existence of a peer-to-peer network of interconnected nodes running a blockchain-based service infrastructure, with at least 30 nodes currently operational in each of the 27 EU member states, as well as Norway and Liechtenstein.

Document traceability is one of the key areas where this network is to be implemented. As a result, several pilot projects have been launched to investigate how blockchain technology could be used to create one or more public ledgers where digital documents are registered, with one of the goals being to eliminate paper documents.

One of the most successful projects in this field was carried out by the European Court of Auditors in collaboration with Compellio [32], a Luxembourg start-up. It entails the creation of a single traceability ledger where European Court of Auditors documents are registered, any interested party being able to verify their authenticity by accessing the corresponding network. Because of the blockchain's immutability, *'there is certainty that the documents registered on the platform have not been altered over time*' [33] and present current information without the need for further investigation.

Following the completion of the pilot project, the Court identified three cases in which the aforementioned technology could be used in the near future. The most promising project entails the *'ability to legalize documents registered with blockchain technology without the involvement of a notary*' [34].

The previous example is only one of many possible applications of blockchain traceability by European Union bodies. In this regard, document traceability will be integrated in a number of cases, including *'cross-border recognition of certified digital copies of documents (for example, diplomas, transcripts, etc.); traceability of food or other components; and modernization of document legalization processes, such as apostille*' [34].

In relation to the subject of this article, the European Union Intellectual Property Office (EUIPO) is making significant progress in the battle against counterfeit goods [18]. In this regard, since 2018, EUIPO has been attempting to identify *'methods for incorporating blockchain technology into the field of intellectual property rights protection*' [35].

To begin, EUIPO is not aiming at creating a new platform to compete with the existing solutions, such as *'non-fungible-tokens (NFT) platforms*' but rather is trying to develop EUIPO tools that are already involved in the supply chain, in particular, the TMview and DesignView platforms [36].

These platforms were created to help interested parties to gain access to intellectual property rights registered at both the national and European Union levels. As a result of the fact that the registration of a trademark or design can differ depending on the state in which the right of protection is sought, as well as the language barriers that may arise in some cases, the EUIPO, in collaboration with the national offices, established these two supranational platforms to mitigate the existing disadvantages. Both platforms are digital tools that *'allow any user, free of charge, to search the registered trademarks or designs of all participating national offices*' [37]. For example, through DesignView, users can consult the registers of participating offices or organizations and obtain a variety of information *'regarding industrial designs, such as legal status, representations of industrial designs, owner, representative, and so on*' [38].

The next step was to hold a conference to identify potential applications for the implementation of blockchain technology. In this regard, the EU Blockcathon conference was held with the goal of identifying ways in which blockchain technology could be used to combat counterfeit goods. As a result, the creation of a special digital duplicate of a tangible good—also known as the tokenization of goods—was recognized as one of the potential solutions. For example, if a manufacturer intends to introduce a certain number of goods into the single market, he/she must create a digital copy—in other words, a digital token—for each good, allowing customs authorities or anyone else interested in verifying its authenticity.

However, to make the simple tokenization of goods much more efficient, a register containing the intellectual property rights corresponding to the respective tokenized goods must be created. Of course, finding a way to connect the currently existing registers with the blockchain technology used by EUIPO is an option, but we appreciate that creating a new register would be better and easier.

Finally, all of the previously mentioned registers must be linked to the networks managed by the supervisory authorities. As a result, the time required for customs authorities to carry out the control will be reduced because there will be no need to check documents. In Egypt, for example, following a change in customs law, importers of goods were required to register the documents accompanying the goods *'on the CargoX platform prior to shipment*' [39]. This blockchain-based platform allows Egyptian customs authorities to verify the authenticity of documents before goods arrive at Egyptian ports, allowing them to conduct timely investigations. As a result of this legislative change, *'the time for goods release has been reduced from 29 days to 9 days*' [40].

To make it easier to understand how blockchain technology could be used to prevent counterfeit products from entering the single market, the following practical examples are useful.

Everledger is a blockchain-based platform that provides those interested with a variety of tools for tracking the path of a specific type of good from the time it is manufactured to the

time it is purchased by the consumer. Currently, Everledger provides *'tracking services for luxury goods, diamonds, and wine or other spirits'* [41].

In 2019, Everledger developed an *'end-to-end traceability and provenance solution for the wine industry'* [42]. The technology entails the use of plugs with Near Field Communication (NFC) tags that can be read by anyone with a smartphone. These NFC tags are linked to Everledger's blockchain network, which records the majority of the details about each *'individual bottle of wine, including origin, wine characteristics, certifications, varietal name, and carbon footprint'* [43].

In addition to the ability to track the entire journey of a wine bottle from bottling to purchase, Everledger allows users to check whether transport and storage conditions, as well as the temperature recommended by the manufacturer, have been met. This avoids situations in which a genuine good has some flaws that necessitate its withdrawal from the market. Furthermore, the risk of obtaining a counterfeit product is almost entirely eliminated, because the moment the wine bottle is opened, *'a record is made in the blockchain register ensuring that the same bottle cannot be reused for the purpose of counterfeiting'* [44].

Another case in point is Walmart's use of blockchain technology in supply chains for some of their products. In this regard, Walmart, in collaboration with IBM [45], has developed two pilot projects *'aimed at tracking the origin of pork in Chinese stores'* [46], as well as mangoes sold in American stores. Consumers, like in the previous example, can use a smartphone to scan a QR code, which provides *'information on the food's source, geographic location, logistics data, and inspection reports'* [47]. As a result of the implementation of blockchain technology, the food safety of pork and mangoes has increased exponentially, *'while the time required to identify the origin of the goods has been reduced from 7 days to just 2.2 seconds'* [47]. In this manner, contaminated products *'can be removed from the shelves of Walmart stores in a timely manner'* [48], and if these goods have already been sold, *'consumers can check if the purchased good is part of the recalled lot from the market by simply scanning a QR code'* [49].

Following the completion of the above-mentioned pilot projects, IBM created a new network to provide *'the food supply chain with unprecedented visibility and accountability'* [50]. This network, according to IBM, *'links producers, processors, distributors, and retailers via a shared, permanent, permissioned record of food system data'* [50]. Also, through this network, anyone who is interested can find out *'the origin, current location, and condition of any food item'* [51]. Last but not least, organizations can identify *'which foods have been grown or produced in a certified manner, reducing contamination risks and potentially harmful food fraud along the supply chain'* [51].

BrightFarms is an illustration of a business utilizing the technology supplied by IBM. BrightFarms, acording to IBM, *'was founded to simplify and decentralize the supply chain for greens, and to provide consumers with a more sustainable choice'* [52]. Thus, *'the company uses IBM Blockchain on IBM Cloud® to keep data safely encrypted and uploads data to the IBM Food Trust platform through each stage of the process, from the moment seeds are planted until packaged greens arrive at the retailer'* [52]. Furthemore, *'once the greens are on the shelves, the retailer can continue to add data to the platform as well, including how long the greens have been in the store and at what temperature they are being stored'* [52]. From the examples given, it is clear that the uses of blockchain technology that we had initially suggested are already prevalent in the United States, even though in this particular example the supply chain from farm to store is relatively short.

As to the European Union single market, a good example is Carrefour. Carrefour is a *'European leader in food traceability through the gradual application of blockchain technology to its Carrefour Quality Line products'* [53]. For instance, one of the products displayed in Carrefour is the *Purée Mousline*, which has recently been added to this network due to its popularity among French consumers. A barcode is used on the packaging of the

respective product that can be scanned by a smartphone to provide consumers with valuable information about the mix they're about to prepare, such as the region where the potatoes were grown and the varieties used, quality control in the Nestlé factory where the product was made, and the places and dates of storage before it arrived at the grocer [54].

5. Conclusion

To conclude the blockchain technology can be applied in a variety of contexts and is flexible enough to be adjusted for each circumstance. In other words, even though the article's main goal was to show how effective the blockchain technology can be in the fight against counterfeit goods, we have also shown how it can be applied to other situations. In light of this, we began by simply highlighting the steps that a good takes to get to the shelves of retailers. Then, by requiring the registration of labor contracts, we showed how the aforementioned technology can be used to combat the slave labor. Finally, we demonstrated that by integrating blockchain technology with the registers already in place at the level of the European Union, it is possible to track the origin of deforested trees, removing from the market trees originating from illegal logging.

So, based on the examples given, it is clear that incorporating blockchain technology to facilitate the tracking of goods entering the single market could be beneficial and, more importantly, feasible. Among the main benefits identified in this paper, we highlight traceability, which allows both producers and consumers to trace the origin and authenticity of goods, thereby preventing counterfeit goods from entering the supply chain. Furthermore, transparency is a critical factor in increasing consumer confidence in the goods they purchase, which increases the profit of producers who have integrated blockchain technology. Finally, by utilizing blockchain technology, supply chain members *'can record transactions in real time, reducing current time lags*' [55].

In conclusion, blockchain technology has the potential to positively impact the development of the European Union's single market. Currently, European Union bodies must thoroughly investigate what type of blockchain could be more efficient and easily integrated into the existing production chain. Simultaneously, it must be compatible with other existing distributed ledger networks in the private sector, as well as networks managed by other Union bodies such as customs or supervisory authorities. Product counterfeiting may become obsolete in the near future if blockchain technology is extended to the majority of goods entering the market.

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