Fighting fake reviews with blockchain-enabled consumer-generated reviews

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Fighting fake reviews with blockchain-enabled consumer-generated reviews

Online consumer-generated reviews are part of eWOM (electronic word of mouth). These reviews are very important for tourists in their decision-making processes regarding purchases and bookings. The reviews can be found in two types of sources: websites that sell the product and independent websites. In both cases, current review systems have relevant shortcomings: the possibility of fake reviews, the representativeness of those who review, platform decisions than can bias the results and other possible manipulations. Additionally, some users may not feel comfortable posting reviews due to the possible loss of anonymity. In this scenario, blockchain provides a suitable framework for solving most of the stated problems. In this paper, we describe an implementation of an online review system based on blockchain that would help solve most of the problems that exist in the current systems. We discuss managerial implications of the proposed system, possible limitations and future research needed in the area.

Keywords: online reviews; blockchain; consumer-generated reviews; eWOM; TripAdvisor

Introduction

Currently, eWOM (electronic word of mouth) is key for most organizations. Consumers base their purchasing and consumption decisions on the eWOM that they access (Ngarmwongnoi et al., 2020). Electronic word of mouth includes clients' opinions exchanged on social networks, product reviews shared online and discussion forums, among others. Among all these types of eWOM, consumer-generated online reviews[1] stand out. The importance of online reviews for companies' performance has been extensively tested in different fields and sectors (Chintagunta et al., 2010; Ye et al., 2009). Nevertheless, despite the spread and importance of this type of communication,

[1] In this manuscript, we will preferably use the term online reviews, although consumer generated reviews, user generated content (UGC) and eWOM can also be found and are used to refer to this concept.

there are significant concerns about its credibility (Dong et al., 2019) and representativeness (Gavilan et al., 2018) as well as the role of platforms on which eWOM can be found (Mellinas & Martin-Fuentes, 2021).

Many of the first online reviews started in the tourism industry. Currently, these can be found on two basic types of websites. The first type are websites that sell products and allow users to rate these. Some examples are Booking.com, Expedia, Amazon, Airbnb, and Apple App Store. These websites, which allow ratings to be linked to the products being sold, can be further divided into two subtypes: websites where only users who have made a purchase can rate (as happens on Booking.com) and websites that allow anyone to leave a rating (as happens on Amazon). Regarding the latter, it is common for a website to flag users who have bought the product on the website to distinguish them from other reviewers. For example, Amazon includes the tag "verified purchase" next to the rating in these cases. The second generic type are independent websites, such as TripAdvisor[2], Google Maps and Yelp. In these websites, products and establishments are listed with a rating.

For both types of websites, the literature has identified several risks associated with online reviews. First, those wanting to promote or demote a product or a company may introduce fake reviews (Cai & Zhu, 2016). Second, it is not clear to what extent those who post reviews are representative of all those who experience a product (Gavilan et al., 2018; Xiang et al., 2017). Third, the database of reviews is in the hands of the company that operates the website where online reviews are placed (e.g., TripAdvisor, Google Maps). Therefore, companies can make decisions regarding the

[2] TripAdvisor was created as a site to gather online user reviews. Each service was linked to several external sites through which services (e.g., hotel rooms and activities) could be booked. For some time now, TripAdvisor has also directly sold services, such as activities. In this manuscript, when TripAdvisor is mentioned, it will be in reference to the site that gathers online reviews, stores them in a database and presents them to users in their website.

algorithms that may affect the way in which a product is rated (Mellinas & Martin-Fuentes, 2021). Fourth, users who pay for premium access to one of these platforms (e.g., TripAdvisor) may obtain special benefits regarding which online reviews are shown in their profile or how these reviews are presented.

Although research studies have analysed factors that determine if online reviews are perceived by consumers as trustworthy, studies have mostly focused on the eWOM characteristics (e.g., valence or length) and the type of reviewer (e.g., experience or identity). Furthermore, researchers' recommendations for improving consumer trust are limited in scope. These include, for example, guiding reviewers on how to communicate their opinions and incentivizing them to share their reviews on independent review websites (Dong et al., 2019). In general, the research has not offered solutions to the problems with the existing review systems.

Outside the research world, some alternatives have appeared as a way of overcoming the aforementioned problems. One of them is the Open Reviews Association[3]. This platform solves some of the mentioned problems, such as the manipulation, and provides more transparency to the process of posting online reviews. However, it is not the answer to one of the biggest problems — the fake reviews.

In this paper, we propose an alternative that would solve most of the abovementioned problems. This alternative is a system based on blockchain technology, with a blockchain system for each industry in which online reviews take place. The company selling a product (a good or a service) would associate a unique code with each product sold (each good or each service delivered). This code would simultaneously be given to the customer buying the good or paying for the service and sent to the blockchain system. The unique code would be inserted in the blockchain

[3] https://open-reviews.net/

system together with information about the transaction (e.g., time, date, cost, number of people that experienced the service, types of products). Using the unique code, the consumer could include a review of the purchase and could optionally disclose certain personal data (e.g., age, nationality, gender). This review would be included in the blockchain registry, making it available to everyone under certain circumstances. Even if a review is uploaded, the details of the transaction would allow the system to calculate the representativeness of the reviews that have been placed.

Literature review

Importance of online reviews

Interactions with anonymous or unknown businesses always involve risks. Therefore, users tend to trust highly reputed sellers and get recommendations from their acquaintances when dealing with lesser-known sellers. With the growth of online sales, the number of sellers has become much larger, not making it always feasible to use one of the abovementioned criteria for selecting sellers or products. In the case of tourism products, which are intangible and which are usually booked in anticipation of the consumption moment, the need of some type of advice from previous consumers is more relevant, therefore increasing the need for online reviews (Calvaresi et al., 2019). Research has found that online reviews and ratings correlate with the success of products and services (Zhang et al., 2010). In fact, eWOM has been found to have an impact on companies' performance (Xie et al., 2016).

However, eWOM does not have the same importance for all goods and services. Consumers tend to appreciate more reviews of cinema, literature and hospitality. The food sector and other mass consumer products are less impacted by online reviews. Electronic word of mouth is more important for services given their intangibility.

Consumers feel more insecure when choosing services than when choosing goods and therefore tend to seek information about the experiences of other consumers (Papathanassis & Knolle, 2011).

The importance of online reviews in tourism. As other services, tourism services have the characteristic of intangibility, inseparability, heterogeneity and perishability (Kizildag et al., 2020). Thus, online reviews that can reduce the uncertainty inherent in these services are even more relevant. In fact, tourism is one of the industries in which online reviews emerged as in which the importance of online reviews has been highlighted (Litvin et al., 2018). For example, and regarding destinations, Su, L. et al. (2022) found that online reviews impact the willingness to travel and destination trust. For hotels, there is abundant evidence that hotel reviews impact hotel bookings (Wen et al., 2021; Gao et al., 2020; Sparks & Browning, 2011). Due to the effect of online reviews on purchasing intention, the impact of companies' responses to client reviews on potential clients has been investigated (e.g., Liu and Ji, 2019). Online reviews reflect clients' preferences and concerns; thus, studies have performed analyses to determine service characteristics that impact the review, such as the availability of airport transport, room atmosphere and room facilities (Hsiao and Hsiao; 2021). Other studies have similarly used online reviews to analyse clients' characteristics, such as age or type of travel (Liu et al., 2013). Finally, several reviews of the research on online reviews in tourism (Schuckert et al., 2015; Chen & Law, 2016; Mutirala et al., 2020) have indicated that the number of studies has grown significantly and that online reviews are considered a significant aspect of the tourism industry.

Problems of current online review systems

There are two basic types of platforms that host reviews: platforms that also sell the products being reviewed (e.g., Amazon) and those that are only dedicated to online

reviews (e.g., Yelp). In turn, platforms that also sell products can be subdivided into two types: those that allow only consumers who have purchased a product to place a review (e.g., Booking.com, Expedia) and those that allow anyone to post a review (e.g., Amazon). Mayzlin et al. (2014) have found that the reviews on a platform open to everyone (e.g., TripAdvisor) are perceived to be less credible than the reviews on a platform where only users who have made a purchase can post a review (e.g., Expedia). However, other research has also found no significant differences between the reviews of platforms such as TripAdvisor and Booking.com (Martin-Fuentes et al., 2018). This suggests that the authentication of users or the guarantee that the users have made a purchase is somewhat less important than expected.

There are several problems with the existing online review systems. The first one relates to *fake reviews*. As positive eWOM is associated with economic success, companies may be tempted to manipulate the content of online reviews (Karode & Werapun, 2020; Xu et al., 2020). The basic mechanism involves inserting fake reviews in order to promote the seller's products or demote the competitor's ones (Cai & Zhu, 2016; Wu et al., 2020). If everyone can post reviews, those who review a product may not have actually used it. In general, most websites that include ratings of products do not make significant efforts to control fake reviews. For example, some websites may only request users to tick a box confirming that they have really experienced the product or service. Even on platforms such as Booking.com, where only those who have booked can post reviews, there are few checks as to whether the reviewer has really experienced the service. For example, a hotel could ask a user to create a fake booking for one night, pay the commission to Booking.com and then ask the user to create a review (OCU, 2019). If the user booked the hotel at a special rate for a very small cost, the hotel could easily post fake reviews on an independent source such as Booking.com. Several types

of fake reviews have been identified in the literature (Cai & Zhu, 2016; Dellarocas, 2000), the two main being ballot stuffing, which is the practice of injecting high ratings to a target entity, and bad-mouthing, which refers to unfairly low ratings. Cai and Zhu (2016) identify up to six different types of attacks: constant attack, camouflage attack, whitewashing attack, sybil constant attack, sybil camouflage attack and sybil whitewashing attack. Practitioners have warned about customers who even threat businesses with bad reviews if they are not given certain perks (Nadal, 2012). In some cases, it seems almost impossible to distinguish genuine from false opinions (Kizildag et al., 2020). Some studies have estimated that between 16% and 33% of online reviews are fake (Wu et al., 2020).

Although fake reviews can be thought of as isolated actions performed by a specific group of users, or even businesses, the reality seems to be much more complex. For example, SafetyDetectives (2021) uncovered an operation that involved more than 200,000 people creating fake reviews on Amazon.

The literature has addressed fake reviews in several ways, such as analysing the strategies used by scammers (He et al., 2022) and by designing models to spot fake reviews (e.g., Cardoso et al., 2018; Reyes-Menendez et al., 2019; Salminen et al., 2022).

Fake reviews have become so relevant and prominent that legislators in some territories have decided to take action. For example, in Europe, a law has been passed that force platforms to inform consumers how they are ensuring that the reviews they are seeing are not fake ones (European Parliament and of the Council of the European Union, 2019). This same law specifically bans sellers and platform owners from generating fake reviews or manipulating algorithms in order to show products in a positive light. Lastly, sellers are required to take action to ensure that reviewers have actually experienced the product.

The second issue is the one of *representativeness*, which relates to how the profile of those who post reviews compares to the totality of those who experience a product (Gavilan et al., 2018; Xiang et al., 2017). It is well known that the percentage of users who post reviews online is relatively low (between 1% and 10% according to most estimates). However, an issue that is still unresolved in the literature is whether those who post reviews represent a balanced sample of those who consume, or if certain intrinsic characteristics of the consumer or their experience make them more prone to post reviews. For example, there may exist different tendencies to rate products based on nationality, gender, age and tech-savviness, among other possible consumers' characteristics. However, it may also be that users who had an outstanding (positive or negative) experience are more prone to review products or services publicly. This may also be the case for users who consumed more expensive products or those who consumed at a certain time of day.

The third problem with the current online review systems is related to *platform decisions*. Platforms (e.g., Booking.com, TripAdvisor) manage databases of reviews and the front end (i.e., how data are presented to the customers). Therefore, these platforms decide which reviews to show and how to rank products based on reviews. For example, some online review sites consider every review that a product has received while others only consider reviews received within a certain timeframe (e.g., Booking.com takes into account only reviews posted in the last two years). When calculating the global rating for each product, different formulas may be created, giving more weight to more recent scores or to scores from frequent reviewers, among many other possibilities (Mellinas & Martin-Fuentes, 2021). All this means that the company that manages the database and the website makes the final decision on which order products appear in and how the rating is calculated. Companies may even decide to eliminate certain reviews if they

consider that they violate certain norms of the platform. There is also an issue regarding the internal mechanism of the platforms, some of which create rating systems that are not transparent. For example, platforms may remove certain reviews based on internal criteria. Sometimes the platform may decide to change the calculation algorithm (Mellinas & Martin-Fuentes, 2021).

Issues related to platforms and the algorithms used are associated with the risk of *other types of manipulation*. For example, product owners who pay a premium may be allowed to remove some reviews, challenge reviews before they are published and decide which reviews should appear first in product profiles (Karode & Werapun, 2020; Önder & Treiblmaier, 2018).

Another issue regarding online reviews is their *popularity*. Some products may have more than 1,000 reviews, making it impossible for customers to read them all and to get an appropriate perspective of what is being said. For this reason, there is a large body of research dealing with summarizing online reviews (Di Fabbrizio et al., 2013) and with analysing which reviews are more helpful (Bigne et al., 2021; Mudambi & Schuff, 2010).

Blockchain

A blockchain is a database of transaction bundles (blocks) that are linked to each other (chained), and it is replicated (distributed) in all the nodes of the network in which the blockchain is implemented. Before a new block is inserted into the blockchain, it is first validated and authorized to enter the chain by consensus between the participating nodes (Valeri & Baggio, 2021). Being a distributed ledger, there is no central authority in charge, such as a bank, a government or a firm (Cai & Zhu, 2016). Instead, each node of the network keeps a copy of the blockchain. Blockchain uses digital signatures and cryptography to secure and authenticate transactions (Fiorentino & Bartolucci, 2019).

Once a transaction is introduced into the blockchain, it cannot be modified or deleted, which guarantees a permanent registry of operation. Therefore, if a certain transaction needs to be cancelled or is wrong, a new transaction would have to be introduced that cancels or updates the original transaction. Both transactions would be available so that the transaction history can be replicated at any time. Thus, transactions are disintermediated, secure, automated, permanent, incorruptible, irreversible, transparent and traceable (Erceg et al., 2020; Karode & Werapun, 2020; Khan, 2015). However, there is no guarantee that the content in the blockchain is free of errors (Nam et al., 2021).

Blockchain is also able to provide users with control over anonymity: every transaction is visible to everyone who has access to the system, but users can decide if they want to remain anonymous or if they want to disclose (parts of) their identity (Erceg et al., 2020). However, some authors question this guarantee of anonymity and state that hackers could find the IP address of the user (Zheng et al., 2018).

Blockchain has evolved through different versions (Erceg et al., 2020; Luo & Zhou, 2021). The first one, released round 2008, is associated with the use of blockchain for developing bitcoin and other initial cryptocurrencies. In 2014, the second era started. It included smart contracts and Ethereum emerged as the most recognizable platform. Smart contracts are computer codes that execute automatically when certain conditions are met, thus protecting the parties in the agreement and lowering intermediation costs, since there is no need for a third party to enforce the terms of the agreement (Demirel et al., 2022). Two main criticisms were posed to this version of the blockchain: performance and cost (Luo & Zhou, 2021). In 2016, the third era of blockchain started. Hyperledger is the umbrella project for this new version, which tries to solve problems found in the previous versions (Luo & Zhou, 2021)

The main capability of blockchain is that is has a chronological record of all the transactions that have taken place (Aste et al., 2017) since each block of transactions has a timestamp and a unique reference number (hash) (Gupta, 2017). This capability can be used in several areas, such as finance, supply chain management, e-commerce, and many others. In general, it can be used whenever some type of trust is required between parties executing a transaction (Sun et al., 2016). In this case, the trust is achieved by establishing total transparency of the chronological order in which the transactions were carried out and by the fact that once the information is entered into the blockchain, it cannot be changed.

Usually, there is a specific blockchain configuration for each sector, industry or business area in which it is implemented. These configurations consist of different technologies, tools and methods (Rejeb et al., 2020). For example, the consensus mechanism can be *permissioned*, which implies there is some type of organization that coordinates the system used in private blockchains and who identifies the final user and grants them access to the blockchain (Mucchi el al., 2022), and *permissionless*, which refers to open systems used in public blockchains (Valeri & Baggio, 2021).

Blockchain technology is not exempt from possible problems, such as majority attacks, where an attacker gets control of more than half the network (Önder & Treiblmaier, 2018). Another drawback of blockchain is that for a new transaction to be added to the blockchain, an agreement between the participants in the network needs to be reached, which is complex and costly (Cai & Zhu, 2016) both in terms of money and time.

Blockchain use in tourism

Most of what has been explained about blockchain technology in the previous section applies to the specific case of travel and tourism. Blockchain can be used for loyalty

programs and verified rating and review systems (Alghamdi, 2021; Kowalewski et al., 2017; Kwok & Koh, 2019), payment and cryptocurrencies (Dadkhah et al., 2022; Treiblmaier et al., 2021), tracking and service customization (Kizildag et al., 2020), disintermediation of operations (Rashideh, 2020; Rejeb et al., 2020), innovative loyalty programs, including those linked to sustainable behaviours (Tyan et al., 2020), smart contracts (e.g., agreements between hotels and OTAs, management of the loan of cultural objects in museums, management of the relation between guests and hotels regarding bookings) (Demirel et al., 2022; Mucchi et al., 2022), identity management (Kwok & Koh, 2019), luggage tracking (Önder & Gunter, 2020) and smart cities and smart tourism (Kizildag et al., 2020; Nam et al., 2021). The traceability enabled by blockchain is also a way to ensure tourists are having access to local food (Baralla et al., 2021). Last, blockchain is one of the core technologies behind metaverse tourism (Koo et al., 2022).

However, and as Luo and Zhou (2021) point out, the currently available proposals about blockchain in tourism are mostly conceptual and unable to solve the main tourism challenges, with most of the claimed advantages not having been proven (Valeri & Baggio, 2021).

Blockchain and online review systems. Blockchain seems especially well adapted to solve most of the problems related to online reviews. For example, it could address fake reviews by implementing permissioned systems in which every user would need to be authorized before posting a review (Dadkhah et al., 2022). However, most of the currently available studies mention online reviews only tangentially and briefly (e.g., Erceg et al., 2020; Dadkhah et al., 2022; Filimonau & Naumova, 2020; Irannezhad & Mahadevan, 2020; Kwok & Koh, 2019; Reyes-Menendez et al., 2019; Su, K. W. et al., 2022). The only developed proposal is that by Martens and Maalej (2018), on which

this research builds. Martens and Maalej (2018) proposed a fully decentralised system based on Ethereum and smart contracts and described the use case of mobile apps. Their main concerns were whether reviewers had purchased the product and whether any reviews were excluded or modified. In other words, that the database of reviews was untampered. However, they did not specify what happens with sales that are not reviewed (i.e. considering the representativeness problem) and how to avoid sellers colluding with buyers to introduce fake reviews (they only mentioned that each user should be able to submit only one product review).

Transparency and traceability are key regarding online reviews, since they limit the possibility of tampering by the platforms (Irannezhad & Mahadevan, 2020; Rejeb et al., 2020). Blockchain also gives users the choice to maintain their anonymity or disclose whatever they want (Tyan et al., 2020) while guaranteeing that the review is not a fake one (Liu & Park, 2015). Some studies have proposed avoiding flooding the platforms with fake reviews by charging a certain fee to the users (Soska & Christin, 2015). We do not believe this to be a feasible alternative, because the amount of reviewers could decrease significantly and their representativeness could worsen.

Objective

The literature has highlighted that most blockchain advantages have not been proven (Valeri & Baggio, 2021), that most of the proposals are conceptual (Luo & Zhou, 2021) and that they do not really solve the main problems travel and tourism faces. Treiblmaier (2021) suggests that researchers should sidestep technological specifications of blockchain and instead focus on blockchain's main characteristics to develop models that provide value to the industry. With this in mind, the objective of this manuscript is to provide a model for online reviews based on blockchain that will enable solving most of the problems of the currently existing systems.

The proposal

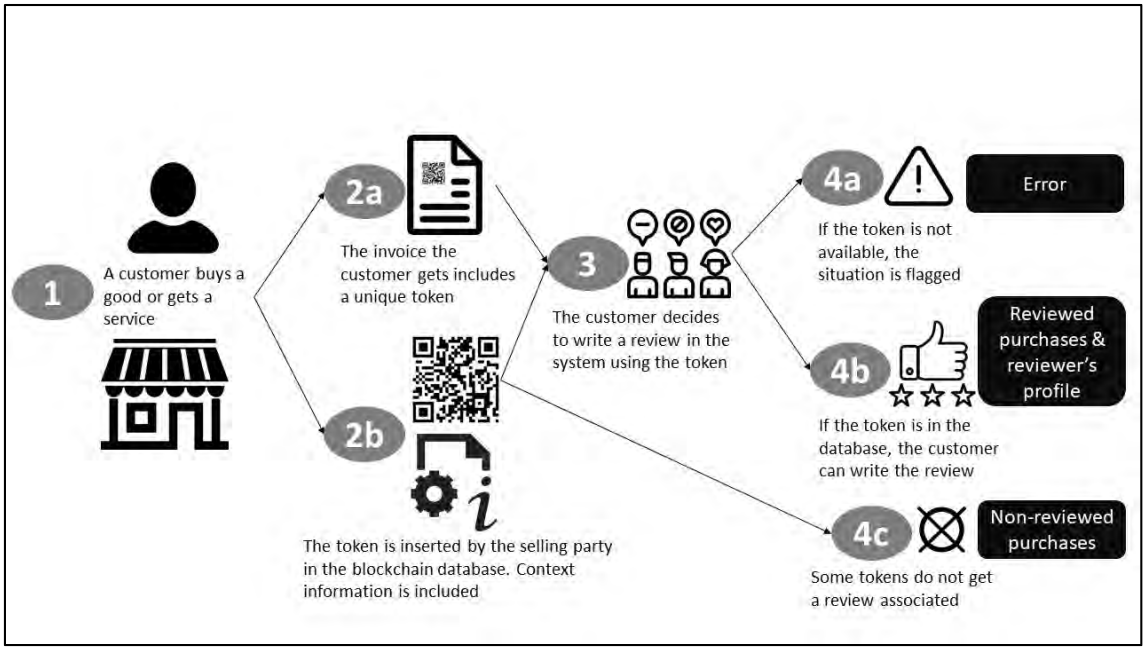
As previously stated, the use of blockchain or blockchain concepts to develop online review systems has already been proposed (Martens & Maalej, 2018). Our proposal builds on Martens and Maalej's (2018) one. Our main contributions are that we propose that every transaction (whether it finally gets a review or not) is included in the blockchain, and that additional information on the product and the consumer is associated with the transaction. Both these contributions address the issue of representativeness and of providing additional and valuable information to participating firms. Although the proposal reduces the possibilities of contributing with fake reviews, one of the issues that it does not fully solve is the possibility of firms and reviewers colluding. However, in this proposal some types of colluding can be detected.

Our proposal is as follows (see Figure 1):

- When a user or a group of users pays for a product (good or service), the invoice includes a unique code (token) as a barcode, QR code or other similar alternatives.
- The seller introduces the code in the blockchain with context information, such as the total amount of the purchase, the time and date, and the type of product or service, among other information. This code needs to be inserted within a certain period after the transaction (e.g., one hour).
- If the user wishes to review the product or service, they could do so by entering the unique code in the system and including the review.
- The user must have a profile in the system including personal information (e.g., age or gender) that could be disclosed in each review, maintaining an adequate level of privacy.

- If the unique code is not available in the system, the user could flag this situation and provide a proof of the existence of the code (e.g., a picture of the token on the invoice). Once it is verified that it is an error and it is corrected, the user will be able to upload the review.
- If an establishment is caught repeatedly in a situation of not uploading the tokens to the system, punitive measures could be implemented.
- There will be a basic front end, developed by the proposer of the service, that presents the information in a very simple manner and with as little elaboration as possible.
- The information in the blockchain (e.g., establishments, purchases, reviews, user characteristics) are available to those wishing to develop new front ends to present the information. Those wanting to do so will have to ask for access to the database from the proposer of the service and agree to comply with certain governance rules (e.g., mentioning where the information used in the front end came from).

Figure 1. Proposed system



The characteristics of the proposed blockchain system are as follows:

- *Permissioned*. These types of systems are more suitable for enterprise contexts. The blockchain would be managed by a central authority in each sector in which it is implemented, such as a chamber of commerce or a hotel association. This central authority could examine the proposals for the development of front-end systems and grant access to the database upon the approval of a proposal.
- *PBFT consensus mechanism*. The practical byzantine fault tolerance (PBFT) algorithm is best suited for the proposed application because it provides low latency storage systems and large numbers of transactions but does not require a high capacity.
- *Hyperledger*. Hyperledger is considered one of the standards for enterprise blockchain platforms. It is an open-source project in which permissioned participants in a network share data.

The proposed system fulfils the four basic criteria set forth by Martens and Maalej (2018): only those who have purchased can review; review authors are distinguishable; each author can post only one review per product version (in this case, we consider the delivery of a service a version); and authors are not charged for inserting a review. Our system also fulfils the research proposition by Önder and Treiblmaier (2018) by providing a trustworthy rating system in which personal identities are not revealed, users are not able to create duplicate reviews and no one can manipulate reviews after they are posted (Kizildag et al., 2020).

Application of the proposal to tourism services

As has been explained, while a decentralized blockchain approach to online reviews is useful in every area of the economy, it seems especially appropriate is the case of

tourism services such as hotels, restaurants and activity providers, among many others. Depending on the specific area of the tourism sector (e.g., hotel, camping, P2P accommodation, cafeteria, activities, airline, rent-a-car), there would be a different blockchain specification. Table 1 shows how the proposed system based on blockchain compares to two well-known online review systems such as TripAdvisor and Booking.com.

Table 1. Online review systems problems and type of online review platforms

Issues	TripAdvisor	Booking.com	Proposed system based on blockchain
Reviews can be modified or removed by the platform	Yes	Yes	No
Consumers without a prove of consumption can review	Yes	No	No
Consumers may not see to all the reviews an establishment has received	Yes	Yes	No
Consumers have data on how representative the reviews are	No	No	Yes
A central authority decides how establishments are shown	Yes	Yes	No. Anyone can develop a front end
Establishments and consumers can collude	Yes	Yes	Yes. Easier to detect

The proposed system has several advantages for participants. For businesses, it means participating in a system that guarantees that fake reviews are severely restricted. Businesses also receive valuable contextual information regarding each review, for example, what products guests ordered or what services they consumed. This contextual information will allow businesses to know which products and contextual variables drive satisfaction and dissatisfaction. For reviewers, participating in the system means that the platform will not allow businesses to modify their reviews, thus guaranteeing that the review will be published unmodified. It will also guarantee that reviewers will access real, unmodified reviews when evaluating services. For this reason, the front-end systems to be developed for users to introduce reviews must have a high degree of usability so that users do not need to possess technical expertise to use the system,

whether acting as reviewers or consulting reviews. Finally, consumers who read online reviews will have a trustworthy platform because neither companies nor platforms can manipulate online reviews. Additionally, the likelihood of fake reviews is lower than it is with current platforms.

Discussion

In this manuscript, we have proposed an online review system based on blockchain concepts and technologies. Although the proposal should theoretically be able to solve most of the problems associated with the current online review systems, there are several issues that need to be discussed.

As has been explained, one of the main concerns with the current systems regards all types of fraud. The literature has indicated that the detection of fraudulent raters is a challenging task since there are different ways to camouflage oneself (Cai & Zhu, 2016). Although the system proposed here will be able to eliminate some of the existing frauds, it has certain limitations.

For example, it would be possible for a restaurant to invite friends to make a small purchase (e.g., a drink in an upscale restaurant), which would create a valid ticket that would allow the customer to post a review. The cost of the purchase would be the total cost involved in the operation for the restaurant. However, by comparing the sum of the ticket to the average ticket of the restaurant could lead to flag this review as possibly fraudulent. Most users would not make the effort to analyse each review in order to make sure that the purchase makes sense and that it matches the type of establishment it is associated with. This is something that could be implemented by the front-end system, which could flag these types of reviews as potentially fraudulent. For example, the reviews could be given a different weight depending on the number of

products and the total transaction amount. In this case, small transactions would be assigned low weight in the final score of a product.

The literature has proposed solving this type of fraud by limiting the number of reviews that a seller is allowed to introduce in the system (Schaub et al., 2016). We do not believe this to be a good idea since the drawbacks would outweigh the benefits: sellers could only give tokens to very satisfied customers or to buyers of certain products (Cai & Zhu, 2016).

Although blockchain systems are computer-based systems, and the cost of computing is constantly decreasing, following Moore's Law, blockchain-based systems have a certain cost that is not irrelevant. Martens and Maalej (2018) calculated that with the costs of computing in 2018, the cost of each review in their proposal (which is somewhat similar to the one in this manuscript) could be anywhere between $0.25 and $1.09, depending on the required speed. This amount seems rather high considering that, in the case of restaurants, we are dealing with transactions that in many cases involve relatively modest amounts. However, more recently, Karode and Werapun (2020) found that the costs would be much lower, probably in the range of one order of magnitude less than the one found by Martens and Maalej (2018). In all the cases, the costs vary considerably, even tenfold, due to a number of decisions that have to be made in the implementation process. The most important decision relates to the speed required from the system and implies a trade-off between speed and cost.
In general, it does not seem that speed should be critical regarding online reviews. However, although not critical, it can be relevant.

In the specific case of tourism services, there is the question of who can review services. In the case of goods, there is usually one owner of a good, although some goods are used by more than one person (e.g., a car or a TV). In the case of tourism

services, the following is usually the case: more than one guest stays in a room, more than one tourist enjoys an activity, more than one customer has a meal. In the case of restaurants, there could be a large group composed of 10 people or more. The question is what to do in these cases. There are several possible options. One option would be to allow only one member of the group to create a review. This would be similar to what currently happens at Booking.com, where only the guest who books a hotel can review it. Another option would be for the system to automatically print out a code for each member of the group and then associate those reviews with the same transaction. This would also make it possible to create a review with a certain weight depending on the number of people in the party or even depending on the number of people in the party that ended up reviewing the service. We believe this second option would be preferable since it would allow all participants to review.

Another issue regarding the weighting of a review is that there should be different weights depending on the length of the stay or the type of order in a restaurant. Currently, all reviews on TripAdvisor have the same weight regardless of the total length of stay. This is a criterion that should at least be open to discussion.

While the system here proposed partially solved the representativeness problem (i.e. it is possible to calculate the proportion between those who review and the total number of products sold), it is not a solution regarding possible biases in those who review. This is, little is known about those who do not review.

Lastly, as the literature has pointed out (Nam et al., 2021; Zheng et al., 2018), the blockchain does not guarantee that the information introduced in the system is reliable. If wrong information is submitted, it will be uploaded to the system. Thus, mechanisms would have to be developed in order to make it easy for businesses to quickly flag a transaction as wrong and to correct this mistake at a reasonable cost.

Conclusions

While most proposals discussing blockchain applications have analysed them from the technology perspective, this manuscript is one of the first to analyse a blockchain application from the business perspective and to discuss the integration of a blockchain system in a specific sector — travel and tourism.

The proposal included in this manuscript can serve various purposes and be of use to different stakeholders in the tourism sector. Consumers can have a greater trust that the reviews they are seeing have been posted by clients who enjoyed the service and that the database has not been tampered. Businesses can almost completely avoid fake reviews, have real representativeness of the reviews as well as context data associated with the review. Developers can create front-end interfaces using the reviews available and compete in usability of the system instead of competing in trying to get the review from the user, as for example TripAdvisor, Yelp and Google Maps currently do. Therefore, and although our proposal is more complex than the currently existing online review systems, it improves significantly these systems, making it reasonable to adopt it.

Our proposal is not free of certain issues, such as the cost of the system as well as the need for some type of administrative organization that would develop, launch and maintain the system.

Implications for businesses

Businesses that adopt this system would have certain costs associated with implementing the blockchain-based online rating system (e.g., change in the point of sale [PoS]). There would possibly also be some costs associated with the maintenance of the global system.

However, the advantages for businesses would be manifold. First, the system would guarantee the veracity of the reviews, ensuring that those reviewing are really customers. This would also increase the consumers' global trust in the system, which would be worthy for the market and subsequently beneficial for the business.

In addition, it would be much easier to trace the review, by connecting the consumption characteristics (e.g., time of day, group size, products consumed) to the rating obtained. Also, the system proposed would make it possible to understand the specific characteristics that make users more prone to review, as well as to obtain the representativeness of the reviews. Finally, companies could get specific and valuable feedback about why reviews are favourable or not because they could know the context and particular products of each transaction reviewed.

How should hotels, restaurants and other travel and tourism businesses approach this new model? We believe that the best would be for associations located in the same geographical area to start with implementing initial prototypes. This would allow the businesses in the region to start experiencing the system and understanding the new model.

Limitations and future research

The system we have proposed has several limitations. Some of them are inherent in the blockchain systems (e.g., sustainability due to energy consumption) while others are specific to our proposal (e.g., the costs of writing in the blockchain, which we suggest should be assumed by the proposer of the system and the organizations involved).

Blockchain-based systems for online reviews is an area for future research. The first issue, which has already been mentioned, relates to the need to find an easy and fast system to amend the blockchain if there is a mistake by any of the parties. For example, it could be the case that the user inputs a correct code in the system but makes a mistake

and uploads a review of another product they experienced. There needs to be a mechanism to correct this type of mistakes easily. In addition, there should be an analysis on how to present the information to the user (i.e., the front-end system) in order to have systems that are balanced and unbiased. This relates to the problem of how to provide a representative review when a large group has experienced the same product, and how to provide a representative review when the total expenditure in each case can vary significantly. One possibility would be associating a simple open-source front end with the proposed system that presents the information with as little elaboration as possible. From there, more complex front ends could be developed.

As previously stated, the proposed system severely restricts but does not fully eliminate fake reviews since businesses and customers could collude to input them into the system. Previous literature has suggested that in a permissioned blockchain as the one proposed here, users would have to be authorized in the network before posting a review (Dadkhah et al., 2022). Furthermore, if users repeatedly experience the same service, they receive a code with each invoice, thus allowing them to review the same service more than once. The current proposal does not consider this issue. Future development could connect different reviews by the same user for the same service.

Finally, the system proposed in this manuscript is better suited to services than goods. Different sellers usually sell the same good, and an invoice can include several goods. The system could be adapted for use with goods, with minimal changes, in which the review of the seller should be different from the review of each of the products sold.

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