Viewpoint
A critical reflection on the adoption of blockchain in tourism

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Abstract
The viewpoint discusses the impact of blockchain technology adoption on tourism. We highlight a gap in the tourism management literature. Based on a number of published works and the few implementations existing in the tourism domain we critically reflect on the ability to capture benefits, and to enhance the effectiveness of this technology. Starting with a description, often missing, of the basic architecture and functioning mechanisms of a blockchain system we discuss potential drivers and drawbacks of its adoption in the tourism domain, highlighting the managerial implications of its use. Given the gap in tourism management literature, we also suggest possible research directions for better understanding and evaluating the applicability in tourism and hospitality.

Keywords: Tourism, hospitality, technology, innovation adoption, blockchain, small and-medium enterprises, managerial implications

1. Introduction

The adoption and exploitation of appropriate technological innovations play an important role for several reasons, the first of which is challenging the knowledge base of the organization and its ability to absorb competencies that have been developed elsewhere. A second reason involves the possibility to extend a technological innovation to the overall organizational structure, thus strengthening the business structure and facilitating the exploitation of environmental opportunities. A third reason involves the possibility to increase the accessibility and availability of resources, stimulate collaboration between firms for innovation exploitation, and favor access to external financing or technological expertise. In an ever more competitive environment, blockchain is an innovative technology that can be applied in various sectors of the economy. Its key concept and main objective are to create a new generation of decentralized and disintermediated platforms,

where the trust between the subjects involved can be guaranteed through an algorithm instead of a centralized organization.

Born in the 1990s, blockchain technologies allow organizations to have a higher degree of process automation in an organizational network (Valeri 2016). In particular, blockchain facilitates the creation of a large database composed of a set of 'blocks' (every block may contain one or more transactions) interconnected between each other and distributed over a peer-to-peer network: to perform, every transaction must be controlled and approved in some way (Versace et al. 2018, Baggio and Fuchs 2018).

Although quite a recent technology, global investments in this field are constantly growing, reaching 945 million dollars in 2017, with forecasts to be increased of around 81,2% by the year 2021 (International Data Corporation, 2018). The American market is the one investing in blockchain solutions more resources than any other (about 4.2 billion dollars in the next few years) (Statista, 2018). Europe is the second most important geographical area for investments: in 2017 about 400 million dollars were spent that are expected to become more than 3.5 billion in 2022, even if presently only 3% of European companies has a blockchain project (Capgemini, 2018). In particular, in Italy there are currently four blockchain start-ups which raised only 70 million euro by ICO in the first part of 2018 (Capgemini, 2018). In the Asia-Pacific region the application of blockchain has become increasingly common: China, for example, considers blockchain as a pillar of development for the Chinese economy and currently 51% of Chinese enterprises has a blockchain strategy (Cognizant, 2017).

Blockchain systems have been recently introduced also in the tourism sector and applications deemed able to ease transactions between the parties are being developed mainly pushed by the importance of the role intermediaries play in this context. For example, Webjet (via Rezchain https://www.rezchain.com/) runs an inventory of available rooms in hotels on a dedicated version of Ethereum. Furthermore, adopting "smart contracts", a blockchain can be used to manage transactions reducing the need of other intermediaries (Nam et al. 2019). As a further example, Cool Cousin (https://www.coolcousin.com/), an evolution of Lonely Planet and Tripadvisor, registered about 500 hundred users in just 3 years.

Besides the success of other digital transformations, the implementation of a blockchain technology offers significant benefits (infrastructure costs reduction, traceability and transparency, increasing of revenues, risks reduction, creation of new business opportunities and greater focus on customers), although there is an evident resistance to its application by entrepreneurs due to several factors such as the difficulty of defining a practicable business model, the uncertainty of economic benefits, the lack of specific regulations and standards, the poor development of technological infrastructures, or the inadequate security of payment transactions (Capgemini, 2018).

This paper discusses the impact of blockchain technology adoption on tourism and of the state of the art of academic research in this area. Our analysis could be useful to advise decision makers about its potential adoption in the tourism and hospitality domain and to inform future research directions.

2. Blockchains in a nutshell

Although so far scholars have produced only a limited number of studies on the topic, blockchains are the subject of quite a number of popular publications (articles, commentaries, blog posts etc.). The great majority of the literature (scholarly and popular) uses very positive or even enthusiastic attitudes towards this new technological development. It has been praised for its promoted characteristics of being secure, decentralized, disintermediated and 'democratic'. Most of these advantages, however, are not really 'proofed' (at least in the common scientific sense) so that we might well consider blockchain as belonging to one of the categories of myths described by McKercher and Prideaux (2014). The decision of whether to adopt this technology or not should be founded, in fact, on a careful evaluation that considers the context, the conditions and the peculiarities of both the 'object' and the environment that is going to use it. This requires a good understanding of the technical aspects and of the organizational and governance requirements (at least from a conceptual point of view) and not only a passive acceptance of the buzz generated on and offline.

The ideas at the basis of this technology arose at the beginning of the 1990s (see e.g. Haber and Stornetta, 1991) but found a first practical application with the appearance of Bitcoin, described in a working paper by Nakamoto (2009). The paper proposed a solution to the double spending problem in digital money by resorting to a peer-to-peer network that enables people to use a digital currency without resting on a financial institution or relying on third parties or other intermediaries. In a short period of time Bitcoin's popularity has grown incredibly and has generated a wealth of clones. This great success induced many to consider the possible applicability of the technological architecture on which these currencies are based to other domains.

There is no "standard" definition of blockchain, but it's generally understood as *a growing list of records, called blocks, which are linked using cryptography. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data* (en.wikipedia.org/wiki/Blockchain). Blockchains are members of the larger family of distributed ledger technologies (DLTs), distributed databases that are shared and synchronized across multiple sites.

From a technical point of view the system, actually, is made of two major components: the chain of records and a consensus mechanism (i.e. a shared validation) that allows records to be inserted into the chain. The whole system is implemented using a peer-to-peer architecture (Özturan et al., 2019). The chain is, by design, resistant to modification of the individual records and of their temporal sequence. In other words, once a record is inserted into the chain it cannot be altered without modifying all subsequent blocks. In theory this possibility exists, but it would require the agreement of the majority of the peer-to-peer network (event considered to be highly improbable). The records can hold any 'digital' content depending on the application: transactions (monetary as in a cryptocurrency, or generic commercial exchanges), contracts, passages along a supply chain (e.g. for ensuring the origin of products), educational records, individual identity and so on.

The integrity of the blocks and the chain is ensured by using a simple idea. For each block a hash function is used. This is a special algorithm that provides a kind of fixed-length 'digital summary' of the record. The function is built so that even a small modification of the original

block produces a different hash value. The hash is a one-way function: the only possibility to rebuild the original record from its hash value is by trying all possible records. On the other hand, the verification of the validity is a very simple operation obtainable quickly with simple programs. Before generating the hash value of a block, the hash value of the previous block is added. In this way it is possible to ensure the integrity not only of a single block but of the whole sequence (blocks can also be further encrypted for enhancing security). The chain is managed by a peer-to-peer network in which all the parties follow a protocol for inter-node communication and the validation of new blocks. Each record can be examined by any member of the system that can individually verify the authenticity (i.e. the lack of any modification) of each block and the integrity of the sequence (typically temporal). This *distributed ledger* technology (the term indicating a more general family of technologies that includes blockchains) thus allows us to have a distributed, secure, unalterable (in practice) database of records that would be quite complicated and resource-consuming if implemented in a 'traditional' way.

The second component of a blockchain system is essentially the implementation of an algorithm for validating a block and authorizing its insertion into the chain. Depending on the type of *consensus mechanism* (as they are termed) adopted, two families can be identified: permissioned and permissionless blockchains.

A permissioned blockchain uses an access control layer to oversee the admission to the network. This is owned by an entity (a company, a group, an organization) that manages the right to enter the system and, more importantly, the right to validate the records to be added to the chain. In this implementation only some defined trusted parties can perform this procedure that can also be automated for speeding up operations. A permissionless blockchain, instead, is a completely open system that any interested actor can join. The openness poses, obviously, the problem of what method to adopt for the validation of the blocks. Since any member can submit information and try to add it to the chain, it is necessary for the blockchain peers to assess and agree on all additions before they are permanently integrated into the chain. Not having (in principle) any assurance of the actor's trustworthiness, all new blocks must be evaluated and endorsed before being accepted. This review is known as 'consensus'.

Several proposals have been made for a consensus protocol (e.g. the long review in Wang et al. 2019), which is today a very active and dynamically evolving field in computer science, with an ongoing discussion on what is the most effective and efficient method. A consensus protocol is used to reach agreement on a value in distributed processes or systems. They contain a specific set of rules that nodes need to follow to ensure a block (and the chain) is valid. By design, a consensus algorithm is implemented to be quite difficult to imitate or replicate by being extremely costly to carry out, in terms of time, computing resources required or holdings of other peculiar elements. Usually a reward is given to the first node able to solve the puzzle and propose a valid block.

As an example, the current consensus protocols used by Bitcoin are so expensive in terms of computational requirements that only a few nodes can afford the enterprise (the first six handle 70% of the transactions as reported by www.buybitcoinworldwide.com/mining/pools/) and the overall energy consumption is quite impressive, it is deemed to be comparable to that of a country such as Portugal or Romania (digiconomist.net/bitcoin-energy-consumption).

Other implementations claim to be much more efficient and less resource-demanding, but no real demonstration has yet been produced.

Typically, permissioned blockchains are private (i.e. implemented inside an organization, a company or a group) and the permissionless ones are public. However, other combinations are possible, as the distinction is made only based on the consensus protocol adopted. Depending on the choices made in the adoption of a specific model, a blockchain system can be a useful and efficient system or a time and resources consuming technological gadget.

As a final point, it must be noted here that despite the calls for 'certification', a blockchain only plays the role of a *notary* that records instantaneously and without intermediaries a transaction on whichever asset: contracts, buildings, money, shares, files and so on. In no part of the whole system there is a function that guarantees at all that the information published on the blockchain is true, meaningful or even legal, unless the consensus mechanism validates the record. But this is a function 'external' to the system. The very technology at stake cannot enter into the merits of the truthfulness of the information, it merely registers it, guaranteeing only immutability and position in the chain of records.

3. Blockchain technology adoption in tourism

Among the various business automation systems, blockchain represents an innovative technology with the potential of redesigning the organizational structures, lightening the business processes and, in this way, making the companies more competitive. The literature on innovation and strategic management (Penrose 1959; Barney 1991) shows that the adoption of technological innovations is not yet considered to be a key element as it should be, especially by small and medium-size enterprises (SMEs) (Abell 1980; Porter and Millar 1985; Henderson and Venkatraman 1993; Premkumar 2003; Riemenschneider et al. 2003; Harrington and Ottenbacher 2011; Valeri 2019).

On the other hand, it is long known that technological innovations can help improve the management system (Wernerfelt 1984; Dierickx and Cool 1989), also when, as in the case of SMEs, the majority of presences in the tourism domain, resource limitations might restrain their ability in seizing profits from technological innovations (Clemons 1986; March 1991; Grant 1991; Kettinger et al. 1994; Tidd et al. 1997; Rothaermel and Deeds 2004; Beckman et al. 2004; Lavie et al. 2010). Further, some scholar maintain (even if only generically) that the adoption of cryptocurrencies as payment systems will influence trends in tourism industry of the coming years (Mofokeng and Fatima, 2018). Others (Pilkington and Crudu, 2017) argue that the combination of blockchains with other modern tourism 2.0 may help attenuate poverty by removing corruption issues.

In the international travel and tourism scenario there are very few significant cases of blockchain adoptions. Some large companies have started using DLTs. Examples are some airlines such as Singapore Airlines, Air France or KLM that use these technologies for tracking of the status and location of assets such as passenger bags or spare parts, the identity of crews and passengers or contracts with other actors of the supply chain (IATA 2018). Another notable example is the TUI Group (https://www.tuigroup.com/) that manages its internal smart contracts and have developed BedSwap, a project that relies on a blockchain-enabled system to maintain records of hotel bed inventories in real-time. A series of start-ups are also actively

working in this area. Examples are LockTrip (https://locktrip.com/), or Winding Tree (https://windingtree.com/).

These companies typically offer services to businesses and customers for property management, bookings, baggage tracking, payments. The main claim is that the use of a secure decentralized system, allows to run the services with no middlemen and no commission fees. The latter is especially stressed. However, a deeper scrutiny reveals that although a no-commission transaction is claimed, a transaction cost exist and, what is more, it relies, for the monetary exchange, on some of the known cryptocurrencies (Bitcoin, Ethereum etc.) or on their own (LIF for Winding Tree) which might increase the costs in a seemingly unpredictable way due to the high variability of the quotations (exchange rates) of these currencies. In other words, there are no commissions but transaction costs and exchange rates, which can be seen as another way of naming the same matter. Actually, the only real innovation is represented by the possibility to use distributed peer-to-peer techniques and the possibility of easily verify if any object (transaction, document etc.) has been modified and by whom, thus ensuring a de-facto non-modifiability (Valeri 2020).

4. Research on blockchains in tourism

Tourism is definitely one of the industrial and economic sectors that could benefit widely from this technological innovation (Hassi, 2019), mainly due to its strong dependence from any form of information and communication technology. However, from both an academic and managerial perspective, it is not easy to identify the exact degree of influence it can have. In fact, several elements, such as network externalities, technical difficulty, consistency, testability or perceived requirements of relevant advantages can affect the possibility to adopt successfully these technologies (Valeri and Baggio 2020a; 2020b). Conventionally, the adoption and diffusion of a technological innovation are linked to the number of users who have profitably adopted it, and up to now, this seems to be a very weak point. Moreover, as for many innovations, the high level of marketing buzz surrounding blockchains may run the risk of considering them as a panacea for many of the problems afflicting the business world. On the other hand, some scholars and practitioners treat DLTs as an ephemeral phenomenon, destined to a limited spread in the near future. The truth is that to date, as said, blockchain has already started to have practical applications in several economic fields, thanks to its ability to solve a number of issues triggered by the rapid growth of the undergoing digitalisation process. Tourism, as it already happened for other technological advances, lags a bit behind.

In this situation, as often happens, we might resort to scholarly research to gain some better understanding of the whole matter. After all, we maintain that (Werthner et al., 2015: 10): "Research is a main driver for developing and advancing a field." However, a literature search found only on a handful of relevant papers and that does not seem to provide much meaningful insights or discussions. Not only limited in number, the literature is also limited in scope and extent; the current discussion on DLTs and blockchain technologies does not seem to have, up to now, expressed a good and thorough analysis of these themes (Treiblmaier 2020).

Some future research proposals have indicated possible avenues such as the one by Önder and Treiblmaier (2018). They propose to verify the following statements: 1) updated methods of rating and review technologies will conduct to more reliable evaluation systems; 2) the

extensive use of crypto currencies will point to new models of C2C markets, and 3) Bitcoins will lead toward a major disintermediation in the tourism industry. Some also claim that responses to these types of questions would contribute to a new style of tourism industry in a blockchain perspective (Ozdemir et al. 2019). Similar position is expressed in the recent paper by Rashideh (2020) that reports a survey run by interviewing experts in this field. However, we note that among the experts selected no industry operator can be found, but only consultants, business analysts or software developers. Thus, probably, they are more influenced by the current marketing buzz than by the real experience of the mechanisms behind the 'intermediation' of tourism products. In this case we also note that this is the first example of a paper containing a description of the technical aspect of a blockchain implementation.

All in all, it is difficult to understand why a topic so popular in the information technology literature (scholarly and popular) has received so little attention. One possible explanation is that, too often, academic research in tourism is a follower of some phenomenon and very few works really try to anticipate environments and situations. Moreover, the literature very seldom investigates other domains trying to 'import' and 'translate' the outcomes generated elsewhere. Since very few operational application examples exist it is difficult to analyze rigorously advantages and disadvantages. To this we could add the not widely diffused knowledge about the details of the technicalities of these architectures. In fact, practically no published work provides a good and thorough technical description of the functioning mechanisms and of the requirements in terms of resources and skills needed to successfully employ these systems, and very few works address the possible effects of the adoption of blockchain technology in tourism and hospitality (Valeri 2015).

From the readings of the materials it is clear that the main focus of the scientific production so far appears to be on rather generical features and on the possible organizational questions for future adoptions. Moreover, there is also a lack of empirical research that highlights both the advantages and the critical issues of a possible implementation in the tourism domain. We further note that, since few cases offer a reliable and clear description of the technical aspects of a blockchain system, this might lead to underestimate some problems, for example the enormous resources needed for operating a pure 'public' and open system and arouse enthusiasms that cannot be reasonably satisfied in the long term. On the other hand, a poor technical appreciation of the technology risks causing an underestimation of the real advantages for what concerns the management of the distributed data and of their security characteristics (Sabou et al. 2016; Mariani et al. 2018).

The impact of blockchain technology on the competitiveness of an organization might depend mainly on its practical application in relation to the different needs and challenges. It is clear that the implementation of a blockchain technology will be effective where: 1) there is a strong need for asset exchanges (whether physical or virtual) among the various actors; 2) there is a need to have a common repository that is shared among the different parties involved in the production process; 3) the productive process involved is specialized and complex, and includes a certain number of intermediaries; 4) there is a need for strong and reliable security measures; 5) the operation chain is complex and needs a number of 'trials' that are stable over time (traceability); 6) there is a will (or a need) to have automatic processes and transactions, carried out almost in real time; 7) there is a need for shared solutions among the different actors of the domain; 8) there is a request for a continuous verification and monitoring of the different steps;

9) a production process must be based on trust among all the actors; 10) the technological solution is an option to automate some business process.

By drawing from the (even not numerous) empirical evidences in diverse economic fields, the benefits of the implementation of a blockchain technology in tourism might be the following: 1) time saving in the carrying out of procedures; 2) reduction of bureaucratic delays related to the exchange of information; 3) reduction of management, control and data protection costs; 4) decrease of errors and humans interventions in the management of data; and 5) set up of new relational dynamics.

Figuratively speaking, this is a technology that travels at a very high speed. Its applications are numerous, but it, clearly, will not represent the much-heralded solution to many problems in the tourism domain. The many weaknesses and criticalities need to be addressed as soon as possible in a thorough yet realistic way, connecting a good knowledge of the technical, organizational and market potential with a faithful view of the conditions and the possibilities of companies, groups and destinations. To this extent, we note again that the discussion on the possible advantages or disadvantages of an adoption of these technological systems, as for what acquired from the current tourism and hospitality literature (but also from much popular press materials), is strangely lacking, with only one exception, a description, even at a high level, or an explanation of the functioning mechanisms and the basic architectures. It seems, at least for what is possible to understand, that the good marketing buzz on the topic generated by the many advocates and enthusiasts has been accepted rather uncritically, without a thorough evaluation of the different impacts of the many possible realizations. Probably, the highly fragmented nature, at least in many countries, of the tourism domain results in a lack of the skills and resources that would be needed to fully grasp the potential of these technical systems and this might have an influence also on the interests of many tourism researchers that typically follow more closely the state of the current technological applications with often only a limited view on their evolutions (Valeri and Fadlon 2018). In other words, there are still too little real implementations to be investigated and scrutinized.

5. Concluding remarks: a call for deeper analyses

In discussing the evolution of the relationship between information technology and tourism Xiang (2018: 149) states: "*Research on IT and tourism has reflected the general understanding of how technology changes our society and economy. Within this very short period, our view of information technology in its relation to tourism has shifted from a marketing-driven tool to a knowledge creation tool.*"

If research has to continue to fulfill this objective (creating knowledge which is valid from both a theoretical and operational point of view), there is a more stringent need for a more profound understanding of the many aspects a technological system has, including its technical details and the possible economics, organizational, operational and social impacts. This, like any other new development in the computerized treatment of information plays, and will play very probably, an important role in the tourism and hospitality domain. There is a good potential for research activities in this field to contribute to the understanding of SMEs' behavior, performance and growth, substantially in a more effective way than it currently does.

Obviously more 'tourism' application cases would be needed for a deeper understanding, but, an initial attempt a more thorough examination of the uses in other different domains could be useful. As in many other cases, and as well and long known in the practice of scientific investigations working by analogy can provide good hints and advices (Daniel, 1955; Gentner, 1983; Gentner and Jeziorski, 1993; Olson, 1943). After all, even if there are some specificities, as in any particular environment, a tourism or hospitality operator is a company, typically of small size, and as any other company has operational problems in treating transactions, contracts, sales, payments, managing a supply chain, establishing reliability of the origins of goods and so on. Exactly the areas in which blockchains have application. So, a good understanding of these issues can be of great benefit also for the tourism and hospitality domain.

For practitioners, and mainly managers, DLTs and blockchain technologies can have, when well assessed and evaluated, a positive impact on the overall productivity of companies and organizations by better automating and reducing the load of routine processes. At the same time there is an undoubtedly positive effect on the control and reduction of frauds, the security of sensible data, the management of contracts, payments and tax liabilities, and, in general, an effective support of business intelligence activities.

Without forgetting the need of solid theoretical framework, we believe that deeper and more rigorous studies on these topics may offer good progress possibilities and push this domain beyond the boundaries of academic research, improving business performance and providing the tools for making them more competitive. In this direction the recent call for a transformative research (Gretzel et al., 2020) seems to be very appropriate, especially when calling for a thorough examination of past achievements in order to attain a more creative stance with regard to these technologies.

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