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Smart contract applications in tourism

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Abstract:
Based on blockchain technology, smart contracts promise to revolutionize the way parties legally agree. Smart contracts could enable tourism service providers to trade directly with customers bypassing some intermediaries. The study aims at identifying the provided services, economic impact, partners, popularity, technical and technological factors of smart contract applications in various tourism areas. It investigates ten popular smart contract applications that cover a wide spectrum of tourism areas such as hotel reservations, airline tickets, car rentals, payment management, reward programs, traveller identity, luggage tracking, validity of reviews and ratings, and more. These applications are analysed with respect to their purpose, business model, economic impact, partners, provided services, popularity, as well as what cryptocurrency and blockchain they use. Smart contracts enable time and transaction cost savings, convenience, flexibility, security, trust, ease verification of personal data, and more. Most applications gained popularity mainly during 2018-19. Almost every application uses a different cryptocurrency. Ethereum is the most popular platform followed by Hyperledger Fabric and Stellar. The development of a universal legislation as well as interoperability is a necessity for the wide adoption of smart contracts.

KEYWORDS: blockchain applications; cryptocurrencies; luggage tracking; smart contracts; travel management; travel agencies.

1. INTRODUCTION

Blockchain technology is an open-source software, a decentralized database which includes chronologically ordered block records that are available in millions of locations simultaneously (e.g., Yaga et al. 2019). During the first generation of the blockchain technology, bitcoin was introduced. The prevailing view is that blockchain technology is the solution to the lack of trust in transactions and this is because it has the following characteristics: 1) decentralization (absence of central authority), 2) security (use of cryptographic keys), 3) automation (e.g., automatic execution of smart contracts), 4) stability (each block is directly connected to the previous ones), 5) integrity (right to anonymity), 6) transparency, 7) reduced costs, 8) trust and 9) traceability (Niranjanamurthy et al. 2019). These characteristics are also found in smart contracts, which in combination with their mode of operation pave the way for the consolidation of a new generation of contracts. A contract is a legal document that binds the involved parties and contains their rights and obligations. The administration of a contract concerns the contract's planning, negotiation, bidding and agreement. For efficient business operation, it is important to ensure both trustful contracts and trustful contract's administration.

However, the administration of a contract is usually a complex and costly process. Thus, smart contracts were invented.

Smart contracts appeared in the second generation of blockchain technology, although the idea of smart contracts dates back much earlier. Szabo (1994) defined them as *encrypted computer transaction protocols, which execute the terms of an agreement without the intervention of an intermediary-third party* (e.g., bank, lawyer). The goal of smart contracts is, among others, to reduce fraud and breach of contract, as well as to reduce transaction costs. A smart contract is an all-digital contract, which is not recorded in writing, but is certified through the use of digital signatures and cryptographic keys. It is a computer code, which "runs" in a blockchain environment and includes all those agreed terms, which when met, will result in the automatic execution of the respective contract. More specifically, a smart contract is a self-executable computer program that contain the terms and conditions of a contract between the involved parties. Based on blockchain technology, it verifies and executes an agreement between untrustworthy parties without the involvement of an intermediary trusted third-party (e.g., bank, government, trustee). The terms and conditions of the agreement between the involved parties are written in code and distributed on the nodes of the blockchain network. When the terms and conditions of the agreement are met, the smart contract is automatically self-executed. So, smart contracts can decrease the complexity of contract's administration without the need for human intervention or any intermediaries (e.g., Mason 2017; Nofer et al. 2017). They provide security, trust, integrity, immutability, reliability, accuracy, speed, cost savings, transparency, visibility, accountability, traceability, decentralization among other benefits (e.g., Das et al. 2020; Low and Mik 2020; Mason 2017). More specifically, they provide the following benefits:

- Security: Smart contracts are secured and encrypted. Using blockchain technology, each record is timestamped and connected to the previous and subsequent records on a distributed ledger making it difficult to be hacked.
- Cost savings: Smart contracts decrease the cost of transaction and operation since there are not fees for some intermediaries who have been vanished.
- Time savings: Smart contracts enable participants to save time in planning and managing their contracts.
- Decentralization: Smart contracts store copies of their data in multiple places in the blockchain network. Smart contracts do not rely on a central control authority. On the contrary, the authority is distributed among the nodes of the blockchain network.
- Reliability: Smart contracts are reliable since copies of their data are stored in multiple places in the blockchain network and there is not a single point of failure. The decentralization of the smart contracts ensures redundancy.
- Transparency and Visibility: Smart contracts are transparent and visible since their data, information, and transactions are transparent and visible to all involved parties.
- Immutability: Smart contracts contain data and information that cannot be modified. Also, the records of a transaction cannot be changed and remain permanently distributed in the nodes of the blockchain network.
- Automation: Smart contracts are self-executed automatically without human intervention when the terms of the agreement are met and verified.
- Speed: Smart contracts are self-executed as soon as the terms of the agreement are met and verified without any paperwork to process. In addition, there are not any delays in

intermediaries who have been eliminated. However, there is still delay in the transactions' processing and authorization.

- Accuracy: Smart contracts are accurate since they are secured, immutable, and verified prior to their deployment in the blockchain network. In addition, their automatic execution without human interaction eliminates fraud and human error.
- Traceability: Smart contracts are traceable since their data, information, and transactions remain immutable and can be traced to authenticate their origin and path.
- Accountability: Smart contracts are accountable since they are transparent, traceable, and secured using public key encryption. In addition, misbehaving parties can be identified and held accountable for their misbehaviour.
- Trust: Smart contracts are trustful since they are secured, transparent and visible, immutable, reliable, accurate, accountable, and traceable.

However, although smart contracts may reduce transaction costs, they may also create extra costs for information, expertise, education, energy, malfunctions, and technology (e.g., equipment, storage, programming).

Previous studies investigated the applications of smart contracts in various economic sectors such as banking (e.g., Guo and Liang 2016), accounting (e.g., Chou et al. 2021), auditing (e.g., Rozario and Vasarhelyi 2018), finances (e.g., Hyvärinen et al. 2017), real estate (e.g., Fernandes et al. 2020), construction (e.g., Das et al. 2020; Perera et al. 2020), healthcare (e.g., Novikov et al. 2018; Sharma et al. 2020), tourism (e.g., Joo et al. 2021; Thees et al. 2020), education (e.g., Bedi et al. 2020; Palma et al. 2019), music (e.g., Halgamuge and Guruge 2022), video (e.g., Pertiwi et al. 2020), government (e.g., Gómez et al. 2021), smart cities (e.g., Pradhan and Singh 2021), energy (e.g., Vieira and Zhang 2021), copyright licensing (e.g., Bodó et al. 2018), logistics (e.g., Arumugan et al. 2018), transportation (e.g., Das et al. 2022), and insurance (e.g., Gatteschi et al. 2018). However, the tourism industry lags behind other sectors in the adoption of blockchain technology (e.g., Korže 2019). Next section describes previous studies on blockchain and smart contracts in tourism.

2. PREVIOUS STUDIES

Most previous studies regarding the blockchain technology in the tourism industry discuss drivers, benefits, opportunities, obstacles, and challenges (e.g., Calvaresi et al. 2019; Erceg et al. 2020; Irannezhad and Mahadevan 2021; Rejeb and Rejeb 2019; Valeri and Baggio 2021). Actually, Önder and Treiblmaier (2018) argue that academics have been slow in investigating the potential of blockchain. In addition, several authors (e.g., Korže 2019; Nam et al. 2021; Thees et al. 2020) point out that there is little research in applications of smart contracts to tourism. Blockchain and smart contracts is a relatively new technology and, currently, there are few applications in the tourism industry (Calvaresi et al. 2019; Erceg et al. 2020; Irannezhad and Mahadevan 2021). Most of these applications are at early stages and have been developed by start-ups or research projects.

Although few previous studies mentioned applications of blockchain and smart contracts in the tourism industry (e.g., Rejeb and Rejeb 2019; Erceg et al. 2020; Irannezhad and Mahadevan 2021; Rejeb and Rejeb 2019), there are not any previous studies that explicitly investigate smart contract applications in tourism. So, this study focuses on analysing recent developments of smart contract applications in tourism. It aims at identifying the provided

services, economic impact, partners, popularity, technical and technological characteristics of smart contract applications in various tourism areas. So, it explores and examines thoroughly ten popular smart contract applications that cover a wide spectrum of the tourism sub-sectors. The next sections analyse these smart contract applications in tourism.

3. METHODOLOGY

According to various academic studies, the adoption of blockchain technology and smart contracts by the tourism industry will result in improved travel experience, facilitate cross-border payments, reduce operating costs, etc. (Benduch 2019; Calvaresi et al. 2019; Korže 2019; Önder and Treiblmaier 2018; Valeri and Baggio 2020). However, what is the current state of smart contract applications in tourism and what do they offer?

Next, this study will try to shed light on this topic. It will follow a methodology which consists of the following seven stages: 1) Identification of tourism sub-sectors; 2) Identification of popular smart contract applications in each sub-sector; 3) Investigation of smart contract applications; 4) Identification of evaluation parameters of smart contract applications; 5) Identification of tools to measure the parameters; 6) Analysis of findings; and 7) Reporting of findings.

Based on Antoniadis et al. (2020)'s taxonomy of tourism sub-sectors, we looked for smart contract applications that cover a wide spectrum of tourism sub-sectors. We identified and selected ten smart contract applications mainly based on the frequency of their appearance in the literature, on scientific papers (e.g., in Scopus and Google Scholar) and in general on the Internet (Table 1). After identifying these ten applications, we classified them as follows: i) travel management applications: Winding Tree, Beenest (Bee Token), TravelChain, Rezchain (Webjet), Cool Cousin, TripEcoSys, and Etherisc (FlightDelay); ii) transaction applications: Winding Tree, Beenest (Bee Token), TravelChain, Cool Cousin, Loyyal, TripEcoSys, Etherisc (FlightDelay), and QashBack; iii) identity management application: ShoCard; iv) authentication management applications: Beenest (Bee Token), Loyyal, TripEcoSys, and QashBack (Table 1).

Travel management	Hotel/room reservations; Airline tickets; Security; Car rental.	Winding Tree[1], Beenest (Bee Token)[2], TravelChain[3], Rezchain (Webjet)[4], Cool Cousin[5], TripEcoSys[6], Etherisc (FlightDelay)[7].

[1] Winding Tree: https://windingtree.com/
[2] Beenest: https://coinformant.com/beetoken-merges-with-coinformant/
[3] TravelChain: https://travelchain.io/#/
[4] Rezchain: https://www.rezchain.com/
[5] Cool Cousin: https://www.coolcousin.com/
[6] TripEcoSys: https://www.tripecosys.com/
[7] Etherisc: https://etherisc.com/

Transactions	Payment management; Reward programs.	Winding Tree, Beenest (Bee Token), TravelChain, Cool Cousin, Loyyal[8], TripEcoSys, Etherisc (FlightDelay), QashBack[9].
Identity management	Traveller ID; Luggage Tracking.	ShoCard[10].
Authentication management	Validity of ratings	Beenest (Bee Token), Loyyal, TripEcoSys, QashBack.

Table 1: Classification of Smart contract applications in Tourism

Then we analysed these 10 applications with respect to the following parameters: Business model; Year of establishment; Services provided; Purposes; Cryptocurrencies used; Economic impact; Business partners; Popularity; Number of websites pointing to the application's website; Number of inbound links pointing to the application's website; Distribution of new inbound links over the last 5 years; Blockchain type; Smart contract used.

We gathered information from the official websites of the applications as well as using web analytics tools, research papers, and news on the Internet. Data regarding the total funding and the number of monthly visits to the website of each application were collected using tools such as Crunchbase, SiteIndices. Data regarding the number of other websites and hyperlinks pointing to the applications' websites as well as the age of these hyperlinks were measured using OpenLinkProfiler. Next, we present the findings.

4. FINDINGS AND DISCUSSION

Table 2 shows some general information regarding the establishment of each application. These applications use a variety of business models such as Business-to-Business (B2B), Business-to-Customer (B2C), Customer-to-Customer (C2C). The earliest application (Loyyal) was established in 2014. Most applications were established in 2016-17. Table 3 presents information about the services that they provide as well as their purposes. The applications cover various tourism areas such as accommodation management (e.g., hotel reservation), transportation management (e.g., airline tickets, car rental), payment management, identity management (e.g., traveller's identity, authentication, insurance, compensations, rewards, loyalty programs, customer tracking, luggage tracking), reputation management (e.g., reviews, recommendations, ratings). More specifically, these ten smart contract applications enable tourists to: i) connect to airlines and accommodation; ii) be compensated for using tourist services, for providing information or reviews, and for flight delays or cancelation; and ii) safely manage their personal data. In other words, they facilitate the management of traveller's personal data, preferences, bookings, rewards, compensations, reviews, and other travel activities. They provide convenience, security and personal data protection, easy verification of personal data, automatic transactions, and transparency. Also, they reduce intermediaries, booking errors, and fraud.

[8] Loyyal: https://loyyal.com/
[9] QashBack: https://qashback.net/
[10] ShoCard: https://www.shocard.com/

Apps	General info	Business model	Establishment
Winding Tree	Connects suppliers (hotels, airlines) and vendors (travel agencies) to an open market.	B2B	Switzerland 2017
Beenest (Bee Token)	Direct transactions between accommodation providers and tourists (like Airbnb) (Irannezhad and Mahadevan 2021).	C2C	San Francisco 2017
TravelChain	Exchange of data related to the tourism industry between tourism service providers and tourists (Polukhina et al 2019).	B2C	Russia 2017
Rezchain (Webjet)	Decentralized travel booking confirmation system (Microsoft 2018).	B2C	Australia 2016
Cool Cousin	Variant of Trip Advisor and Lonely Planet. De facto travel agents (Sharma 2021).	C2C	Tel Aviv 2016
Loyyal	Reward platform for customers due to their loyalty (Agrawal et al. 2018).	B2C	San Francisco 2014
TripEcoSys	Travel planning - travel advertising - social networking - e-wallets (Coita and Ban 2020).	B2C & C2C	U.K. 2018
ShoCard	Virtual identity management and secure storage of personal data (Coita and Ban 2020).	B2C	California 2015
Etherisc (FlightDelay)	Compensation platform in case of flight delays or cancellations.	B2C	Munich 2016
Qashback	Decentralized reputation management system - online reviews (QashBack 2019).	B2C & C2C	Singapore 2018

Table 2: General Information regarding the Applications

Apps	Services provided	Purposes
Winding Tree	➢ Vendors upload availability and pricing information into the database, which is visible to everyone. ➢ Sellers buy and pay directly. ➢ Mainly targets hotels, airlines and travel agencies (Business Travel News 2021).	✓ Convenience in seller-buyer interaction. ✓ Plan all aspects of a trip from a single platform.
Beenest (Bee Token)	➢ Property rental. ➢ Automatic dispute resolution. ➢ Rating system (Medium 2021).	✓ Minimize the need for intermediaries.

		✓ Elimination of the dominance of: Airbnb, Booking, HomeAway etc.
TravelChain	➢ Users store data which relate to their preferences regarding a trip e.g., attractions. ➢ Companies request access to this data, they analyse market needs, and make direct offers to customers (News BTC 2021).	✓ Controlled exchange of personal data. ✓ Opportunities for smaller companies to develop.
Rezchain (Webjet)	➢ Examines the provider-customer matching according to the bookings. ➢ In the event of a discrepancy, the parties receive notification in order to make adjustments.	✓ Reduce errors in all stages of a booking. ✓ Resolve any problems before completing the transaction.
Cool Cousin	➢ Users become de facto travel agents in their area to help tourists to plan their trip. ➢ The services provided are about the exchange of information regarding food, tourist attraction, etc. (Stuart 2017).	✓ Management of the platform by its own users. ✓ Immediate and secure exchange of knowledge and services.
Loyyal	➢ Facilitates the transfer of points from one airline to another and to other cooperating travel companies (e.g., cooperating hotels), so that they do not remain unused (insight Success 2021).	✓ Consolidation of reward systems. ✓ Reduction of unfortunate cases that create compensation obligations.
TripEcoSys	➢ Enables travel service providers to expand their business. ➢ Gives tourists the opportunity to gain tokens by uploading useful information and ratings on the platform (TripEcoys 2018).	✓ Strong security and protection of personal data. ✓ Combining travel services with social interaction.
ShoCard	➢ Allows selective and secure storage of personal data. ➢ Allows third parties to verify the validity of the data as well as whether the data has been modified (ShoCard 2019).	✓ Use of the application in the tourism sector (e.g., for identification at airports and hotels) and elimination of the obligation to have an identity card and a passport. ✓ Easy verification of the authenticity of personal data.

Etherisc (FlightDelay)	➢ Compensation due to flight delay. It requires the existence of a smart contract as well as an already scheduled flight. ➢ If the conditions mentioned in the smart contract are met, direct compensation is provided.	✓ Modernization of the insurance system. ✓ Democratization and transparency in the insurance market.
Qashback	➢ Traders have the option to purchase token in order to motivate consumers. ➢ Consumer is paid in tokens after the/she provides a review regardless of whether it is positive or negative (QashBack 2018).	✓ Empower traders and consumers alike. ✓ Elimination of prejudices - Motivate customers to share their ratings.

Table 3: Services Provided and Purposes of the Applications

Table 4 presents the applications' cryptocurrencies and their economic impact. These applications usually use custom-made cryptocurrencies and they enable reduction of costs for operations, transactions, data collection and storage, dispute resolution, compensations, evaluations, advertising, and more. I addition, they enable time savings and risks reduction.

Apps	**Cryptocurrency**	**Economic impact**
Winding Tree	Lif Token (Forbes 2021)	✓ Reduction of transaction costs by 20%. ✓ The only charges are for network maintenance and are very little.
Beenest (Bee Token)	Bee Token	✓ Transactions in BeeTokens are not accompanied by an additional charge. ✓ Transactions in other cryptocurrencies have a commission of 1%, while in other currencies, such as USD, the commission is between 1 and 4% (Irannezhad and Mahadevan 2021).
TravelChain	Travel Token	✓ Companies save money they would give for advertising purposes. ✓ Tourists save money when planning their trip and at the same time profit from offers, coupons and Traveltokens (Polukhina et al. 2019).
Rezchain (Webjet)	(Not a specific one)	✓ Reduction of losses arising from disputes between contracting parties up to 90%.
Cool Cousin	CUZ	✓ Tourists save money and time when planning their trip. ✓ Generating income for cool cousins due to their knowledge offer.

Loyyal	(Not a specific one)	✓ Reduction of the chances of compensation up to 80%.
TripEcoSys	TripPay Token (TCH)	✓ Reduction of transaction costs for tourism service providers due to the reduction of advertising costs and for travellers due to the elimination of intermediaries.
ShoCard	(Not a specific one)	✓ Save money as it is now possible to collect all personal data in a virtual identity, without requiring costs and time to retrieve it from the various services (Rejeb and Rejeb 2019).
Etherisc (FlightDelay)	ETH, DIP (also in USD, EUR, GB)	✓ Reduction of operating costs. ✓ Increase of number of customers due to the immediate compensation.
Qashback	Qashback Token (QBK)	✓ Save money for companies as they do not have to create their own rating websites. ✓ Risk reduction from unreliable ratings (QashBack 2019).

Table 4: Economic Impact of the Applications

Tables 5 and 6 display the applications' business partners and their popularity. Their popularity is measured by the monthly visits to their websites as well as by the number of other websites and hyperlinks pointing to their websites. Crunchbase and SiteIndices were used to record the total funding and the number of monthly visits to the website of each application. OpenLinkProfiler was employed to measure the number of other websites and hyperlinks pointing to the website of each application as well as the age of these hyperlinks. Partners of the applications include airlines, tour operators, hotels, computer companies, and more. Cool Cousin, Etherisc, ShoCard, and Winding Tree are the most popular applications. Thousands of visitors visit their websites every month. In addition, thousands of links point to their websites. The website of Cool Cousin receives by far the most inbound links (Figure 1). On the contrary, very few websites and links point to the website of Rezchain. Table 6 also shows the percentages of new links pointing to the applications' websites during each one of the last five years (2017-2021).

Most applications gained new links pointing to them mainly during 2018-19 (Figure 2). Most articles on Internet that discuss and point to these applications appeared during 2018-19. However, Etherisc gained most of its inbound links during 2021. So, Etherisc mainly attracted attention on Internet during the last year (2021).

Apps	**Partners**	**Popularity**
Winding Tree	Air France, Lufthansa, Air Canada, KLM, SWISS, Austrian, Nordic Choice Hotels, Hobo Hotel Stockholm, etc.	✓ 5,762 monthly visits. ✓ Monthly visits growth: 307.5% (Crunchbase 2021)
Beenest (Bee Token)	WeTrust, etc. (Globe Newswire 2021)	N.A.
TravelChain	HiLYNK, etc. (Medium 2021)	N.A.

Rezchain (Webjet)	Thomas Cook, Dida Travel, Mitra Global, Far East Hospitality, etc. (Irannezhad and Mahadevan 2021)	✓ Webjet is the #1 online travel agent in Australia and New Zealand.
Cool Cousin	NYX Hotel, CanYa, Cunard, etc.	✓ 3,289 monthly visits. ✓ Monthly visits growth: - 64.94% (Crunchbase 2021). Used by over 500k travelers.
Loyyal	Deloitte, IBM, PWC, Capgemini, Emirates Group, etc. (PRNewswire 2021)	✓ 226 monthly visits. ✓ Monthly visits growth: -76.82% (Gomedici 2021).
TripEcoSys	N.A.	N.A.
ShoCard	Netflix, HP, Canon, BubbleTone, OneLogin, etc.	✓ 2,602 monthly visits. (Crunchbase 2021)
Etherisc (FlightDelay)	Atlas Insurance, etc. (Insureblocks 2021)	✓ 15,262 monthly visits. ✓ Monthly visit growth: -24.29% (Crunchbase 2021).
Qashback	My Beauty Malaysia, Oriental Mace etc.	✓ Daily visitors: 6,374.

Table 5: Partners and Popularity of Smart Contract Applications in Tourism

Apps	**No. of websites pointing to**	**No. of Inbound links pointing to**	**Percentages of new Links during 2021; 2020; 2019; 2018; 2017**
Winding Tree	921	2,821	11.8; 14.3; 32.9; 32.0; 9.0
Beenest	N.A.	N.A.	N.A.
TravelChain	231	1,131	8.5; 7.0; 41.0; 39.7; 3.8
Rezchain	3	5	0; 0; 40; 60; 0
Cool Cousin	796	11,290	15.1; 7.6; 29.4; 38.8; 5.4
Loyyal	521	1,397	9.9; 13.3; 21.8; 24.5; 26.6; 3.9
TripEcoSys	48	229	13.5; 7.4; 43.2; 35.8; 0
ShoCard	590	2,336	10.4; 12.7; 16.1; 33.4; 21.1
Etherisc	907	2,493	35.5; 15.2; 20.5; 21.5; 6.9
QashBack	92	236	8.5; 5.9; 74.6; 11.0; 0

Table 6 : Number of Websites and Links pointing to the Applications' Websites

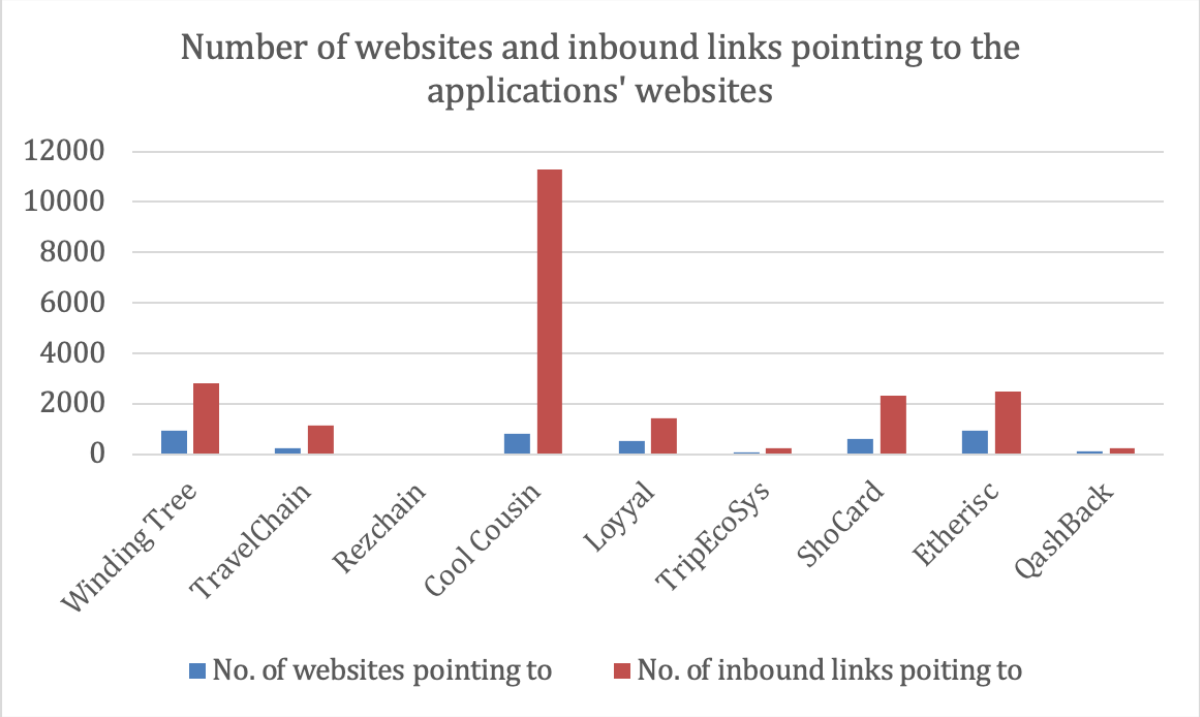

Figure 1: Number of websites and inbound links pointing to the applications' websites

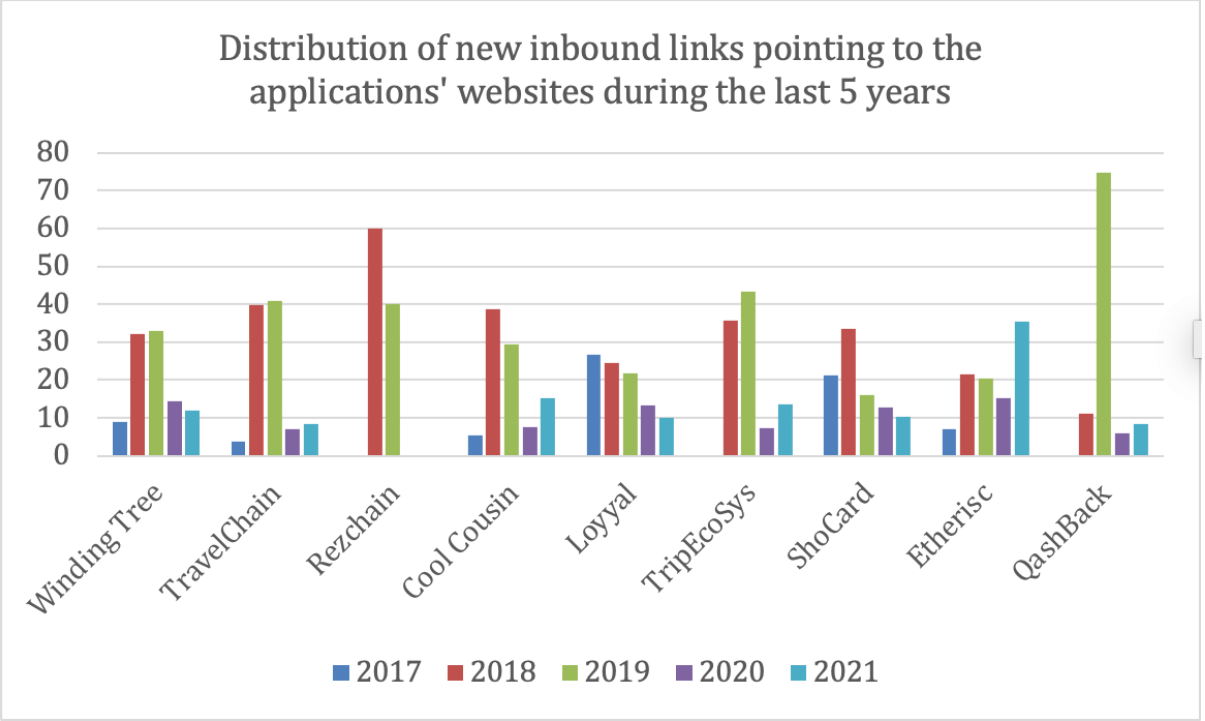

Figure 2: Distribution of new inbound links pointing to the applications' websites during the last 5 years

Finally, Table 7 refers to the technical and technological characteristics of each application and how smart contracts are used. Most of the applications use Ethereum

blockchain which is the world's first and one of the best smart contract platforms. The advantages of Ethereum's smart contract platform include standardization, security, and support. Around 200,000 developers are supporting it. Other smart contracts' platforms include Hyperledger Fabric and Stellar on the Docker environment. Hyperledger Fabric enables high trust, confidentiality, and security of the participants since they are authenticated. Stellar is suitable for simple smart contracts regarding fast cross-border money transfers.

Apps	**Blockchain type/ Open source**	**Smart contracts' use**
Winding Tree	✓ Decentralized open-source travel marketplace. ✓ Licenses used: AGPL for smart contracts. ✓ Apache license 2.0 for libraries and code examples. ✓ Creative Commons Attribution 4.0 International license for all texts found on their websites.	A property management system (PMS) spends a tiny amount of Lif to write info onto the contract. This incentivizes miners. A travel agency (TA) sends the amount of Lif to the contract. An amount of Lif goes to the miner who confirmed the transaction. Note that search from a TA does not require Lif.
Beenest (Bee Token)	✓ Open-source decentralized housing platform. ✓ It is hosted on the Ethereum blockchain.	Insurance policies could be written as coded, decentralized smart contracts in which an individual agrees to pay the insurance company money in return for the company's promise to help cover that person's future medical costs. They can immediately accept or refute any insurance claims made to the company and they can track insurance claims and hold both parties accountable. If any false or fraudulent claims are made by the policy owner (or if an insurance company no longer agrees to cover a condition previously agreed upon), a smart contract will immediately dissolve and the premium payments will transfer back to the individual
TravelChain	✓ Open–source blockchain platform. ✓ TravelChain Core is under the MIT license (Steemit 2021)	N.A.
Rezchain (Webjet)	✓ Rezchain operates on a private Ethereum	Rezchain receives daily booking data of all bookings made or modified between two Rezchain connected parties and are

	blockchain using smart contracts.	stored in a smart contract. When there is a discrepancy or mismatch in booking data presented by both parties, an alert is triggered to tell both parties that they have a data mismatch and should take action to correct the data on one side or the other. If data is received for a new booking from only one party, Rezchain records that as an "incomplete" booking and notifies both sides that one party has the booking recorded and the other side doesn't. Rezchain requires no technical integration on the part of the participating company; a simple daily data file is all that is necessary to begin matching data and solving booking issues.
Cool Cousin	✓ Open–source decentralized platform. ✓ It is hosted on the Ethereum blockchain.	On the Cool Cousin platform, smart contracts establish the rules: define the division of power between The Company and The Community, allow The Community to set its standards and accepts members, creating checks and balances to ensure commercial interests don't taint the content. They guarantee the direct and secure exchange of knowledge and services between travellers and locals around the world. What is more, they guarantee the payment of the cousins corresponding to the information provided. (Bitcongress 2021)
Loyyal	✓ Open-source permissioned decentralized platform. ✓ It works with Hyperledger Fabric (Medium 2021).	(e.g., for airline system) The airline system adds validated member IDs to the blockchain once. Partners append accrued mileage balances to the member IDs. Blockchain verification validates the member data. The airline extracts the partner's accrual data, updating member records and issuing a partner invoice. The partner matches the invoice to the files added to the blockchain and executes the payment (Loyyal 2021).
TripEcoSys	✓ It is powered by Ethereum blockchain.	Seems to support only the part of cryptocurrency exchange (Tripecosys 2021).

ShoCard	✓ Open-source decentralized platform. ✓ It has selected Stellar as its underlying blockchain network (ThePayPers 2021).	Users scan their document with the application, which reads each Machine-Readable Zone (MRZ) and stores an encrypted version on the device. Each field is then one-way hashed, signed with the user's private key, and published to the blockchain. Disclosure of user data is done by encrypting the local copy of information with the receiver' s public key and transferring it via a QR code.
Etherisc (FlightDelay)	✓ The platform is based on open-source smart contracts. ✓ It is hosted on the Ethereum blockchain.	Insurance policies could be written as coded, decentralized smart contracts in which an individual agrees to pay the insurance company money in return for the company's promise to help cover that person's future medical costs. They can immediately accept or refute any insurance claims made to the company and they can track insurance claims and hold both parties accountable. If any false or fraudulent claims are made by the policy owner (or if an insurance company no longer agrees to cover a condition previously agreed upon), a smart contract will immediately dissolve and the premium payments will transfer back to the individual (Builtin 2021).
Qashback	✓ Consortium platform. ✓ All transactions on the QashBack platform are recorded on the Ethereum blockchain (Medium 2021)	N.A.

Table 7: Technical and Technological Characteristics

5. CONCLUSIONS AND FUTURE RESEARCH

Although there is a lot of interest on blockchain and smart contracts, their applications in tourism are limited. This study investigated such applications in tourism. Radical transparency, decentralized character and reduced transaction costs make it easier for contracts to design, configure, and execute. In terms of the tourism industry, which is one of the key players shaping the global economy, it has become apparent that a large number of blockchain technology applications have been created in the last five years, most of which are dominated by smart contracts.

This study analysed ten smart contract tourism applications across a variety of factors such as the following: Business model, services provided, purposes, cryptocurrency, economic

impact, partners, popularity, blockchain type, and smart contracts' uses. These applications cover the following tourism management areas: Hotel reservations, airline tickets, car rentals, payments, loyalty programs, compensations, reward programs, traveller identity, luggage tracking, reviews and ratings, and more. Almost every application uses a different cryptocurrency. Most of the applications use Ethereum platform. Also, some applications use Hyperledger Fabric and Stellar platforms. Smart contracts empower these applications by offering convenience, flexibility, security, trust, transparency, personal data verification, intermediaries' elimination, time and transaction cost savings. Cool Cousin, Etherisc, ShoCard, and Winding Tree are the most popular applications. Most applications gained popularity mainly during 2018-19. Smart contracts could enable tourism suppliers to trade directly with customers bypassing some intermediaries. In tourism industry, intermediaries are essential. However, the more intermediaries the more the transactions' cost, risk, delay etc. The adoption of smart contracts by the tourism industry could eliminate some intermediaries (e.g., trusted third party, payment systems, travel agencies) as well as fraud and human error. Also, the affordances for trust, security, low cost, and transparency make smart contracts useful technology for tourism applications. So, tourism businesses would consider changing their business models, strategies, partners as well as the management of purchases, supply chain, data, records, transactions, logistics, customers' service, sales, payments, and more.

Several applications of smart contracts in tourism aim at connecting directly the tourism companies (e.g., airlines, hotels, restaurants, car rentals, tour guides, recreation, entertainment) to tourists (travellers) by eliminating the intermediaries (e.g., travel agents). For example, tourists may safely store their personal data (e.g., demographics, interests, preferences, rentals, purchases, reviews) in a public blockchain. In exchange for this information, they can receive vouchers which they can spent for booking air-tickets, accommodation, transportation, recreation, tours, attractions, shows, etc. Artificial intelligence algorithms would recommend to tourists (travellers) the most appropriate tourism companies, attractions, itineraries, and more based on their profiles. Thus, tourists would have accurate reviews by other travellers; personalized recommendations based on their profiles; personalized service based on their profiles; lower prices since the intermediaries are removed; exploitation of the coupons; faster identification and authentication; one-stop platform where they can book all their travel services, and more. Correspondingly, artificial intelligence algorithms would recommend to tourism companies the most appropriate potential customers. Then the tourism companies can make personalized offers to each tourist. Thus, tourism companies would have accurate profiles of potential customers; reliable reviews of their performance; higher revenues since the intermediaries are removed; faster service providing, and more.

In the post COVID-19 times, vaccination and test records of tourists may be stored in a blockchain network. Then at entrance control points (e.g., airports, hotels, restaurants, transportation, events), auditors could check these records and allow or not the tourists to enter in the country or in the facility.

The lack of regulations and policies as well as technical standards regarding smart contracts make it difficult to achieve legal and technical compliance all over the world. The creation of a universal legislation as well as interoperability is a necessity for the wide adoption of smart contracts. So, interesting problems for investigation include the development of technical and legal frameworks and standards; interoperability between different applications with heterogenous technologies, different cryptocurrencies and smart contracts; efficient integration of smart contracts with other software and hardware; privacy concerns (either cover

or uncover identity); easy-to-use applications; scalability issues. Other topics for exploration include the factors (e.g., ease-of-use, speed, popularity, interoperability) that may affect the adoption of smart contract applications as well as the effect of smart contracts on various sectors of industry, economy, and society. Furthermore, in order that businesses and users adopt smart contract applications they should be aware of and understand this innovation, as well as have the skills and willingness to invest time and money. So, both businesses and users will need training on the blockchain technology and smart contracts. Future research may also explore enablers and inhibitors to the successful implementation of smart contract in the tourism industry. Finally, future research may analyse smart contract applications in other services' domains too.

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