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DECIPHERING THE CRYPTOCURRENCY IMPACT ON TOURISM DYNAMICS: LEGAL INSIGHTS FROM SPAIN, FRANCE, CROATIA, AND THE NETHERLANDS

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Abstract: The research delves into the nexus between cryptocurrencies and touristic activity, with a special focus on the facet of legal regulations. The study's objective is to fathom how cryptocurrencies influence the tourism sector, how legal standards bear on transactions involving cryptocurrencies within the tourism industry, and to what extent they render the adoption of cryptocurrencies in tourism feasible. The principal aim is to unravel the interconnection between the employment of cryptocurrencies in tourist services and its concurrent legal governance in four handpicked countries: Spain, France, Croatia, the Netherlands The investigation encompasses, on the one hand, the exploration of legal case studies and, on the other, the evaluation of hypotheses using clustering neural networks to dissect the interrelation between cryptocurrencies and tourism. Clustering was achieved through SOM and PCA methodologies, which, in unison, proffer profound insights into the data's architecture and interconnectedness. The data was collected by scraping with an API key, allowing us to examine all cryptocurrency acceptance points by category in each country. During this process, we employed a big data setup. The research underscores that blockchain technologies, including but not limited to Ethereum's advancements that extend beyond just Bitcoin, are steadily gaining a more influential role in tourism. Furthermore, legal guidelines, especially within the EU, have a significant influence on transactions and operations associated with these digital assets. This becomes paramount as, in the scrutinised region, the count of cryptocurrency and blockchain acceptance venues correlates with the vigour of tourism. Blockchain technologies, which transcend just the realm of Bitcoin and encompass advances like Ethereum, are progressively playing a pivotal role in tourism sector. Legal regulations emerge as a cardinal determinant in the governance of blockchain and cryptocurrency-related transactions and operations. The interplay between tourism and these technologies calls for further investigation, especially against the backdrop of a mutable legal environment. However, a conclusion can be drawn regarding its multiplicative impact on the economic pulse of the tourism sector.

Keywords: cryptocurrencies, tourism, legal regulations, blockchain technology, smart contracts

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INTRODUCTION

Since Önder et al. (2017) stated that most academic community is slow in identifying and investigating blockchain's potential impacts, the topic itself has evolved and is the focus of tourism research. Technology such as blockchain also belongs to the latest digital solution to spend money through your own devices. Alexandar et al. (2020) referred to 'app-capitalism' which has also had a strong impact on financial decisions. Cryptocurrency, mainly Bitcoin, has attracted high media attention, so blockchain technology is at the forefront of interest in various industries.

Thanks to this technology, the creation of decentralised currencies (like Bitcoin) can be created, and security is ensured by digital contracts that are called smart contracts. According to the European definition of the Court of Justice - which was in the preliminary ruling of the Judgment in Case C-264/14 - "Bitcoin is a virtual currency used for payments between private individuals over the Internet and in certain online stores that accept it; users can purchase and sell the currency based on an exchange rate." In this Judgment, the Court stated that „the exchange of traditional currencies for units of the virtual currency is exempt from VAT". That decision ensures an important legal background on the tourism market and helps travellers to buy more and higher levels of services.

Furthermore, it minimises the need for a central authority, banks or other third parties (Valeri & Baggio, 2021), like online travel agents (Önder & Treiblmaier, 2018). By these movements, the use of the new era of financial assets (cryptos) is challenging the actual legal solutions, regulations. From this standpoint, the question for the legislators arises as follows. Is the current (old) regime appropriate in all cases or do we have to re-button the jacket? This paper firstly details the importance of modern technology, followed by the specific legal background in the countries covered, and finally the analysis of the aggregated and clustered data on NUTS 3 regions.

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Our research focuses on the European region, including France, Spain, Croatia, and the Netherlands, and tries to explore whether there is a significant correlation between the number of cryptocurrency acceptance points and tourism activity and spending, while also focusing on the legislative background. After reviewing the broader academic context according to the articles cited below, the contribution of this research is to establish the correlation between the use of cryptocurrencies and their acceptance points. By this result, the current scientific debates could be centred around the idea that crypto acceptance stimulates and promotes the development and operation of the tourism sector.

LITERATURE REVIEW

Blockchain, the technology

Blockchain technology is a decentralised and secure system that developed the data management technology for Bitcoin currencies for the first time. This descriptive database consists of a list of transaction blocks, i.e. information and hash collection. These blocks contain all transactions that were previously secured in the chain, and a particular transaction can overtake all substances in the block. The blocks are linked together and form a secure chain (Nakamoto, 2008; Alexandar et al., 2020; Önder et al., 2017; Thees et al., 2020), and a particular transaction can overtake all substances of the block. Blocks are linked together and form a secure chain (Prados-Castillio et al., 2023). Blockchain provides not only data integrity but also security, anonymity (Thees et al., 2020), transparency, trust, privacy (Alexandar et al., 2020), and collaboration among stakeholders (Balasubramanian, 2022), but it is decentralised and can be used without the control of a third-party organisation or government and does not need a human intervention from a legal perspective (Nakamoto, 2008; Balasubramanian et al., 2022; Shen & Bay, 2020). Kowalski et al. (2021) stated that trust in mathematical methods is stronger than trust in authority. Since 2008, blockchain technology has slowly but increasingly influenced the tourism industry (Nam et al., 2019). From a tourist perspective, it improves tourism experience, rewards sustainable behavior, ensures the benefit of the local community and reduces privacy concerns (Tyan et al., 2020) to build trust between the parties and to help solve problems directly. In terms of sustainability, it is important to note that traditional events provide an opportunity for tourists and the local community to enjoy a wide range of local traditions, customs and popular culture (Kőmíves & Vehrer, 2024). By offering more local and organic food, and deliberately introducing new cooking methods and techniques, the food prepared would better meet the changing needs of guests (Kőmíves, 2018). Hungarian cuisine has been renowned and famous for centuries, and we have continued this tradition and passed it on to the next generations (Kőmíves, 2017).

Smart technology, smart contract, and smart destinations

The blockchain can be considered a distributed database that can guarantee the reliability and validity of information. Erol et al. (2018) noted that sustainability is crucial in tourism. The WTO also stated that the installation of environmentally efficient new technology can ensure sustainability goals (UNEP, 2005). Blockchain technology has three generations (BTC Wires, 2019; Nam et al., 2019). The first was the invention of Bitcoin (David et al., 2019), which was followed by the second generation of blockchain technology that enabled smart contracts. The newest third generation of technology enabled smart contracts through applications. Smart contracts are self-executing and self-enforcing contracts based on the blockchain code (Nam et al., 2019; David et al., 2019; Alexandar et al., 2020; Balasubramanian et al., 2022) that was innovated by Ethereum founders (BTC Wires 2019; Nam et al., 2019). These are computerized transaction protocols that apply the terms of the contract (Szabo, 1994 cit. Gans, 2019; Szabo, 2020 cit. Prados-Castillo et al., 2023).

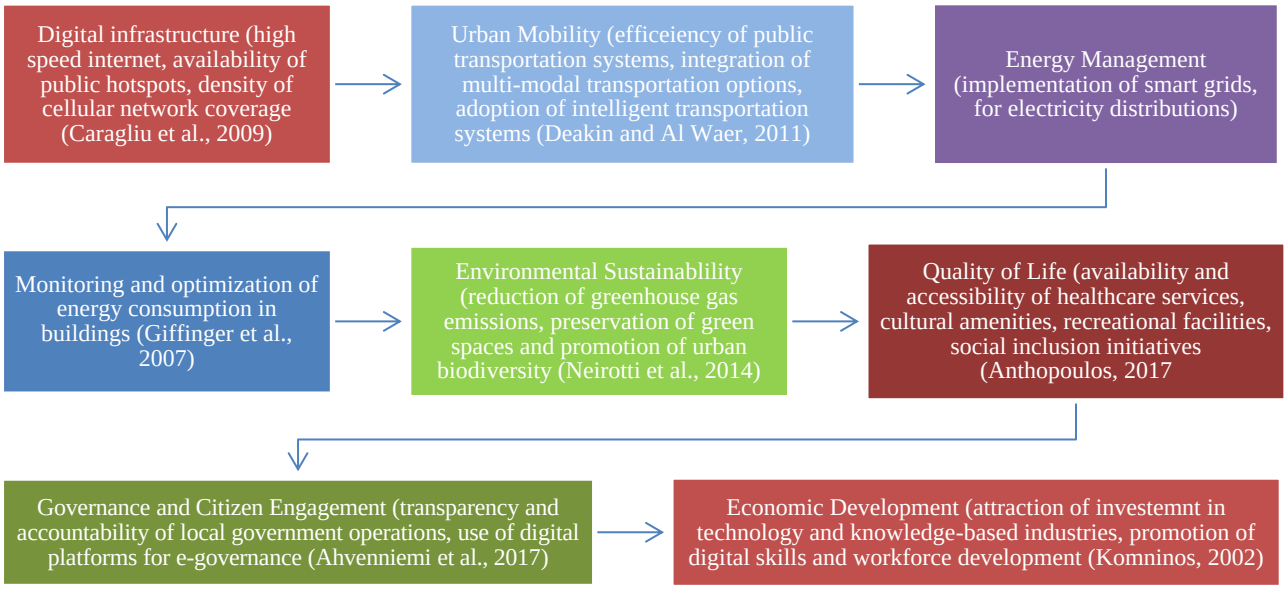

Figure 1. Key indicators of smart destinations (Source: Own edition)

Since data protection is the basis for tourism consumption, technology appears to be a great solution for travelers and service providers. The third generation is called DApps (Decentralised Applications), which allows people to interact more

regularly and familiarly with blockchain technologies on their electronic devices (Nam et al., 2019: 2) and not on a single computer anymore. Nam et al., stated in 2019 that there were more than 2,551 DApps with an estimated daily active user of 78,120. In 2022, the number of DApps on the Ethereum scaling platform Polygon reached 37,000, a 400% increase since the beginning of 2022, and in July 2022, the number of monthly active blockchain teams reached 11.800.

These figures show that interest in and access to technology is growing at an extraordinarily fast rate. The importance of blockchain technology lies in its ability to link a complex data system to identify online consumers (Tyan et al., 2020; Line et al., 2020; Balasubramanian et al., 2022). Smart tourism destinations use different databases and platforms and apply different ICTs to ensure continuous information of tourists and stakeholders. In practice, smart tourism is a combination of smart destination, smart experience and smart business (Gretzel et al., 2015; Baranyai, 2018) while digitalization is vital basis for the destinations development. All three components are necessary for the success, while the destination itself must continue to focus mainly on the improvement and development the local quality of life, but unlike in the past, it also reflects the 21st century needs of tourists. Investment in digital infrastructure and innovation hubs help to to develop innovative smart tourism solutions. Indicators for smart cities destinations are crucial for assessing the effectiveness of technological implementation and gauging progress towards sustainable, efficient urban development. Below you can see Figure 1. with the main indicators commonly used for evaluating smart cities and destinations.

The use of information and communications technologies (ICTs) is inevitable. The use of blockchain technology makes destinations able to achieve four main goals (Tyan et al., 2020): offer better services to improve tourism experience, rewarding sustainable safeguard local communities' benefits and reduce privacy concerns. Real-time information is crucial to tourist decisions. Koo et al., 2017; Tyan et al., 2020 said that new realities in tourism are caused by ICT in destinations, travellers, and businesses. Smart tourist destinations can provide authentic travel experiences by obtaining real-time information on all tourism services, such as tourist tracking, luggage management, fast check-in procedures, and travel insurance to improve tourism experiences (Dogru et al., 2018; Tyan et al., 2020).

These transactions include the preparation and receipt of money, the payment of products and services, the reservation of hotel rooms and flights, the reservation of seats, and the entry into force of a smart contract between the parties (Dogru et al., 2019). Smart cities and destinations with a crypto-economic can be more successful than cities without or without a digital infrastructure (Prados-Castillo et al., 2023: 815). Basis for smart tourism destinations is the smart city and it can improve the experience of tourists by personalising services (Buchalis & Amarangganana, 2015). According to a recent ProtechOS survey, London is one of Europe's 100 most popular cities, followed by Amsterdam, Berlin, Paris, and Lisbon.

The European Commission states that Smart cities are places where traditional networks and services can be made more effective through digital solutions, for the benefit of residents and businesses. The Commission also says that smart tourism is capable of responding to new challenges such as the evolution of digital tools, products, and services, equal opportunities and Access for all visitors, sustainable development of local communities and support for the creative industry, local talent and heritage. The potential of digital platforms and the use of blockchain technology will enable sustainable development. The title Sustainable Tourism Destination emphasises the importance of providing economic benefits to local communities and tourists. The use of B lock chain technology can achieve and contribute to the achievement of these objectives.

Importance of Blockchain Technology for the European Union

Until now, national regulators have responded in various ways, from the wait-and-see approach, warnings to sanctions to avoid compliance with capital market rules. The regulatory response concerned primarily illicit trade, market integrity and customer protection. Despite the activities carried out in individual countries - as will be shown in the next chapter - regulatory intervention often spans a variety of regulators, crypto markets operate globally within the regulatory gap, and have not yet achieved a globally harmonised position. The European Commission is currently developing a legal framework for innovation in the areas of digital assets (tokenization) and smart contracts to protect consumers and provide legal certainty to companies. The Commission strongly supports the pan-European framework and hopes to avoid the fragmentation of legislation and regulation. As the global economy accelerates, the EU is paying close attention to the opportunities offered by digital technologies. One of Europe's progressive pillars is the European Blockchain Partnership (EBP). "The EU wants to be a leader in blockchain technology and to become a pioneer in blockchain technology and a home for important platforms, applications and companies" (European Commission).

The focus of EBP is on the construction of the European Blockchain Service Infrastructure (EBSI). According to EBSI data, in early 2021, 21 projects from 18 European countries participated in the first pilot program. (European Commission - EBSI). According to the European Commission, The Netherlands, France and Spain signed the EBP Declaration on Digital Day 2018. Croatia joined the partnership in 2019 with the aim of avoiding fragmentation of the blockchain landscape by promoting close cooperation between EU countries. EBSI is an interconnected network of nodes running a blockchain service infrastructure. Until 10 April 2021 (last update to the official website of the EBP), the programme had 30 members. (European Commission). The Regulation 2023/1114 of the European Parliament and of the Council on markets in crypto-assets (further defined as MiCA) defines the crypto asset in its Article 3 point (5) as a digital representation of a value or of a right that is able to be transferred and stored electronically using distributed ledger technology (DLT) or similar technology. The MiCA distinguishes between three types of crypto assets as per Article 3 points (6), (7), (9):

1. asset-referenced tokens: designed to maintain stable value by referencing the value of multiple fiat currencies that are legal tender, one or more commodities, one or more crypto-assets, or a combination of these assets.

2. e-money token: the main purpose of which is to be used as a medium of exchange and to maintain a stable value by referencing the value of a fiat currency that is legal tender; and

3. utility token: Provides digital access to a good or service available on a DLT and is accepted only by the issuer of the token in question. NFTs are excluded from MiCa's scope.

The digital opportunities offered by blockchain technology and smart contracts affect public administrations and bring with them the need for regulation. It comes from the fact that major economies have been contentious on blockchain technology and regulation, specifically cryptocurrencies (Kwok & Koh, 2018).

Although EU legislation and its policymaking are of primary importance in the community, the implementing legislation and specific rules of the countries are of direct relevance. In the following sub-chapter, the paper will look at the rules harmonised with EU law in each of the countries discussed.

Legal background of cryptocurrencies in tourism activity in the countries surveyed

France enacted a new genre of regulation through Law n° 2019-486 of 22 May 2019 (Plan d'Action pour la Croissance et la Transformation des Entreprises, PACTE law). Putting aside the European regulator's preferences, France chose to grant an optional visa for Initial Coin Offerings ("ICO"), as well as a combination of required registration for select intermediaries and a voluntary license for everyone. Most laws need an opt-in, but once the choice is exercised, certain constraints apply.France has adopted quite an authentic approach to regulating digital assets, willing to perform a balancing act between sufficiently attracting an elusive and intangible environment towards a more normalised existence.

The Authority of Financial Markets (AFM) is the **Dutch** regulatory body for financial markets. Furthermore, the Netherlands' financial sector is overseen by the Dutch Authority for Consumers and Markets (ACM) and the Dutch Central Bank (DNB). AFM and DNB have issued a taxonomy that is commonly used on a global scale, delineating between three distinct kinds of cryptocurrency.: transaction crypto(s); utility crypto(s); and investment crypto(s). These categories are highly interconnected, as these "cryptos" can have multiple functions simultaneously, and their function can change over time. For example, an investment crypto may transform over time into a utility crypto or a payment crypto.

Cryptocurrencies do not qualify as money (geldmiddelen) within the meaning of the FSA. Under the FSA, money is defined as cash (chartaal geld), scriptural money (giraal geld) and electronic money (elektronisch geld) altogether.

The prevailing view is the Netherlands takes an innovation-friendly strategy with an open but careful connection between regulatory, supervisory, and governmental bodies and market participants.

In **Spain**, cryptocurrency is largely un(der)regulated because cryptocurrencies are not financial instruments under Spanish law. However, there are some main regulations related to the issue of cryptocurrencies.

The Fifth Money Laundering Directive (5MLD) was transposed into Spanish law through Royal Decree-Law 7/2021 (RD-Law 7/2021). Such RD-Law 7/2021 also introduced the most relevant amendments on Law 10/2010 on the prevention of money laundering and terrorist financing (Law 10/2010) including as obliged entities the exchanges of virtual currency for fiat and e-wallet custodian service providers. The main financial services regulation is Spanish Law 6/2023 on Securities Markets and Investment Services ("LMVSI"). The CNMV proposal gives us a normative definition of crypto assets, stating that a crypto asset is a '[d]igital representation of an asset or right that can be electronically transferred or stored by using distributed ledger technologies or other similar ones'. There is no specific regulation on cryptocurrencies in Spain, except that they cannot be treated as legal tender, which is exclusively reserved for the euro as the national currency.

Regardless of your nationality, if services related to "Virtual Currency Exchange for Fiat Currency' or "Services for the Custody of Electronic Wallet Custody' are offered or provided in the Spanish territory, these individuals or entities will have to be registered with the Registry of the Spanish Central Bank ("SCB") created for these purposes. Virtual currencies are defined as 'a digital representation of value that is not issued or guaranteed by a central bank or a public authority, is not necessarily attached to a legally established currency, and does not possess a legal status of currency or money but is accepted by natural or legal persons as a means of exchange and which can be transferred, stored, and traded electronically.' Since 'virtual currency' is a synonym for 'cryptocurrency' the **Croatian** government has implicitly provided cryptocurrencies with a legal definition as shown in Table 1. The fact that the Croatian legislation does not regulate cryptocurrency raises two considerations. First, Croatian authorities do not issue licenses to cryptocurrency companies. However, cryptocurrency investors should be aware that cryptocurrency trading is considered a 'financial transaction' in Croatia.

Table 1. Overview table of the various national approaches (Source: Own edition)

	France	**The Netherlands**	**Spain**	**Croatia**
Main attribute	To establish sui generis regulating attitude	To elaborate a strict and clear taxonomy to empower the crypto development	Unclear, un(der)regulated legal surroundings	Developmental legal surroundings, relying to the regarding acts of the EU
Main act / regulation	PACTE-law	Wet op het financieel toezicht (Financial Supervision Act – FSA)	Law 6/2023 on Securities Markets and Investment Services (LMVSI); Law 7/2021 on the Fifth Money Laundering Directive (5MLD)	None, just a rulebook
Key agents	French Parliament; Autorité des Marchés Financiers (AMF)	Authority of Financial Markets (AFM); The Dutch Central Bank (DNB)	Securities Market Commission (CNMV)	Blockchain and Cryptocurrency Association in Croatia; Croatian Government
Pro / contra	Pro-crypto attitude with a unique approach	The pro-crypto attitude encourages the development and use of blockchain technology, and has a positive attitude toward technological innovations	Highly un(der)regulated legal environment, but proactive defending strategies in favor of the small investors	Pro-crypto attitude and efforts to catch up with EU policies

It is not clear how big the crypto market is in Croatia. The Blockchain and Cryptocurrency Association counts several hundred members. There are 18 crypto companies registered with the authorities in Croatia, according to a list of groups filed with regulators. One of those companies is Electro coin, an exchange that reported €72 million in revenue last year. Its leaders welcome the new crypto regulations despite the compliance process.

MATERIALS AND METHODS

To conduct an in-depth investigation and establish stronger correlations in which aggregated data do not distort the relationships, we determined the level of each of our regional statistical studies at the NUTS 3 level. In this research, the intensity of tourism is interpreted based on the number of nights spent in tourist accommodation according to NUTS 3, for which data were provided by Eurostat (2023). Consequently, a total of 221 NUTS 3 regions were included in the analyses.

The number of cryptocurrency acceptance locations was collected through scraping methodology using an API key. This was based on the CoinMap database, accessed through their official API key. Data collection occurred in September 2023, using Python code within the Jupyter framework. This process collected information about the names, categories, dates, countries, states, localities, and geocodes of the cryptocurrency acceptance locations. To obtain accurate location data, an instance of Geolocator was implemented in the code. Our script was capable of handling external influences, server responses, and other technical issues, managing errors such as GeocoderTimedOut, GeocoderServiceError, and RequestException. Additionally, it checked the validity of coordinates using Geolocator and handled incorrect coordinates.

A total of 20,012 data points were collected for the four selected countries. The NUTS 3 divisions were deduced from the settlement level using Eurostat's LAU list, allowing both tourism- and cryptocurrency-related data to be interpreted at the same level, the NUTS 3 level. To expand our previous research and examine the relationship between cryptocurrencies and tourism, we found it worthwhile to begin by conducting a relevance test. Specifically, we sought to answer the following question: Q1 - In which category are cryptocurrencies most commonly used?

This leads to the Q2 question: if they are most used in tourism-related categories, which is the most popular tourism service used with cryptocurrencies? Given that previous research has shown that tourism demand generally leads in terms of digitalisation level, it is reasonable to assume that if cryptocurrencies are used in the examined region, then H1: they are primarily used in the tourism sector. Furthermore, it is also plausible to assume that the most successful tourist areas keep up with the demand for cryptocurrencies. Therefore, we hypothesise that H2: the number of nights spent in tourist accommodation correlates with the number of cryptocurrency acceptance locations in the examined regions.

RESULTS AND DISCUSSION

On reviewing the established database, several characteristics were observed on the data. In the case of Croatia, presented in Figure 2., several concentrations were observed: Zagreb, as the capital, with a rich cultural and business life, serves as the primary destination for cultural and MICE tourists in the country, as well as the area of Vir and Split, which are central tourism hubs in Dalmatia. Although not regionally, but at the city level, Dubrovnik also stands out as one of the country's primary destinations.

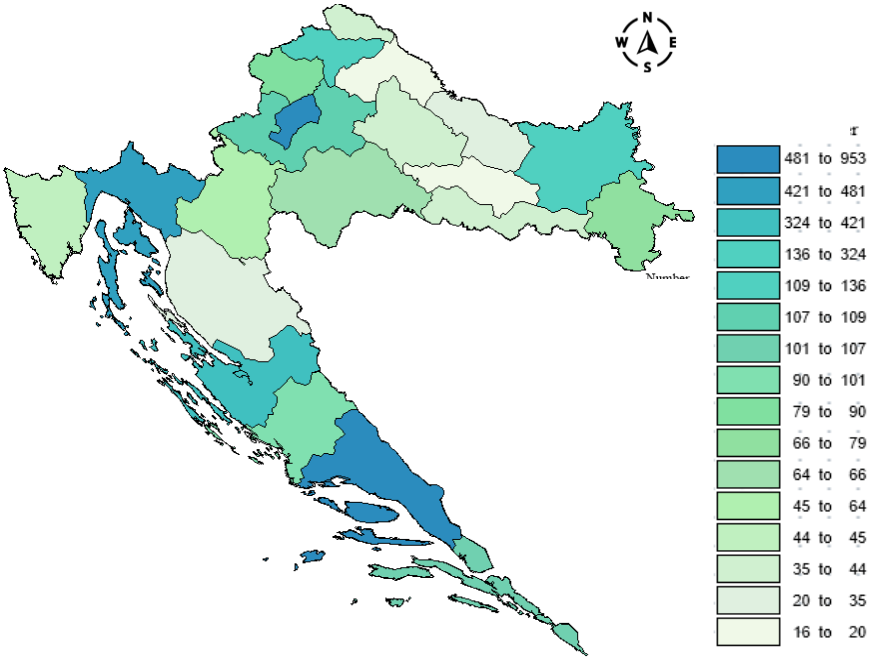

Figure 2. Number of cryptocurrency acceptance locations in Croatia, NUTS3 regional representation (Source: Self edited by own collection)

The number of cryptocurrency-accepting accommodation providers is exceptionally high in the Zadarska županija county (178 cryptocurrency-accepting accommodation providers), the highest number among the counties, indicating the region's touristic popularity. Dubrovačko-neretvanska županija (50 cryptocurrency-accepting accommodation providers) also demonstrates significant touristic allure, especially in historical cities similar to Dubrovnik. Primorsko-Goranska županija (31

cryptocurrency-accepting accommodation providers) likely reflect the touristic offerings around Opatija and Rijeka. Maintaining focus on the research, it is essential to mention the Splitsko-dalmatinska županija county from a tourist perspective, significant for its cryptocurrency-accepting nightlife venues, likely due to the city of Split and the surrounding islands, while Osječko-baranjska županija county is notable for its café cryptocurrency acceptance category.

These data suggest that Zadarska and Dubrovačko-neretvanska counties are particularly attractive to tourists with cryptocurrencies, especially regarding accommodation. The Splitsko-dalmatinska county stands out in the nightlife category, while the Osječko-baranjska county does so with its cafés. Based on the data, these counties could be the focal points of Croatian cryptocurrency tourism. In these counties, where the applicability of cryptocurrencies in the tourism sector is clearly dominant, the composition of service providers was also analyzed. In Zadarska županija county, larger enterprises appear; for example, a supermarket chain is also on the list of service providers, but several apartments, such as Apartman Punta Bajlo and Apartments VIRIĆ, also reinforce the legitimacy of cryptocurrencies: these and similar apartments indicate that the demand for accommodation in the region is significant, showing its impact on tourism.

In the case of Dubrovačko-neretvanska županija, cryptocurrency-accepting accommodation providers near Dubrovnik represent one of the pillars of tourism, especially in the form of high-standard apartments and villas.

In Splitsko-dalmatinska županija, the presence of hair and beauty salons and apartments shows that the region offers comfort, wellness, and private accommodation as opportunities for spending digital currency. On the other hand, Osječko-baranjska županija county differs from the former, where a multitude of local businesses strives to satisfy tourists wishing to pay with cryptocurrencies. Service providers catering to smaller segments of tourism, but essential from the perspective of the local economy and digital currencies, are abundant. In France, several "empty" regions are observable from the perspective of cryptocurrency acceptance locations. However, concentrations are also noticeable.

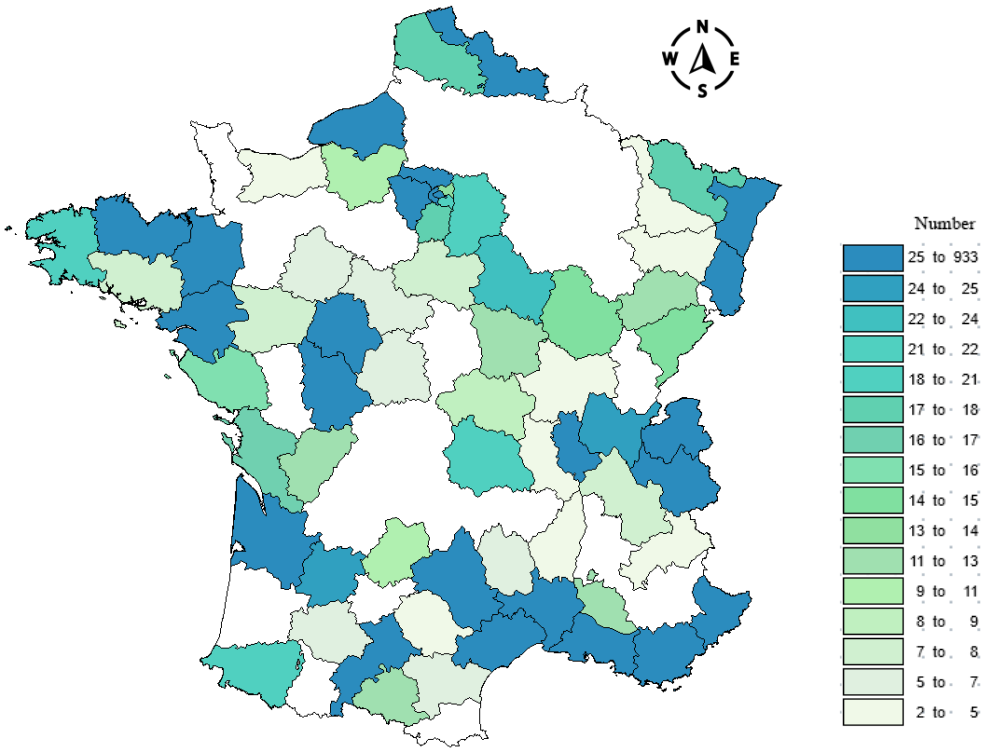

Figure 3. Number of cryptocurrency acceptance locations in France, NUTS3 regional representation (Source: Self edited by own collection)

Based on the analysis of cryptocurrency-accepting service providers in France, as we can see in the Figure 3, Alpes-Maritimes is undoubtedly noteworthy, standing out in the categories of shopping, restaurants, attractions, and transportation. These data indicate that the Côte d'Azur region, especially the cities of Nice and Cannes, are significant touristic destinations, attracting visitors with cryptocurrencies with diverse services. In this region, restaurant chains and players of significant players, tourism experiences, and accommodation services widely accept digital currencies. Bas-Rhin primarily addresses digital wallet holders looking for shopping and attractions, encompassing Strasbourg, an important site for historical and cultural tourism. Naturally, other cryptocurrency-accepting service providers are numerous here, mainly in the technological and commercial sectors, but the region is also significant from a touristic perspective, remaining within the focus of this research.

Aveyron is an excellent location to spend digital currencies, especially for accommodation, as indicated by the significant number of such providers. This suggests that the county focuses on active tourism, such as rural tourism and hiking, when interpreting cryptocurrencies. The high presence of the Gite de la Fontaine accommodation network is an excellent sign of this. Based on the data mentioned, France's touristic geographical peculiarities show significant regional differences, reflecting the touristic profile of various regions, in the aspect of cryptocurrency acceptance. Alpes-Maritimes is distinguished for luxury tourism and coastal vacation opportunities, while Bas-Rhin could be a center for cultural and historical tourism. Aveyron may be attractive for rural tourism and natural beauty.

The analysis could also be interesting regarding the capital city, identifying the following touristic aspects for Paris: The city is exceptionally attractive for shopping, gastronomy, and nightlife from the perspective of cryptocurrencies. The city offers various cultural and entertainment opportunities, attracting tourists and locals alike who wish to pay with cryptocurrencies. The variety of different types of services and the presence of popular restaurants and bars contribute significantly to Paris's touristic appeal in the context of Web3.0, with several chains such as Restaurant Le 43, Sof's Bar, Beaubien, Crea-Shop, Alzon, Nagatomi, Butte aux Tha, and other service providers significantly adding to this.

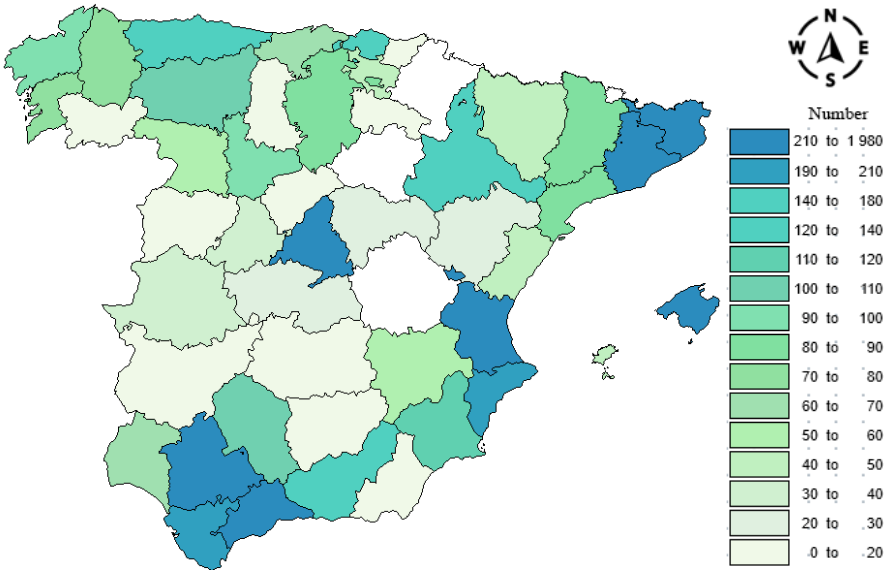

Figure 4. Number of cryptocurrency acceptance locations in Spain, NUTS3 regional representation, (Source: Self edited by own collection)

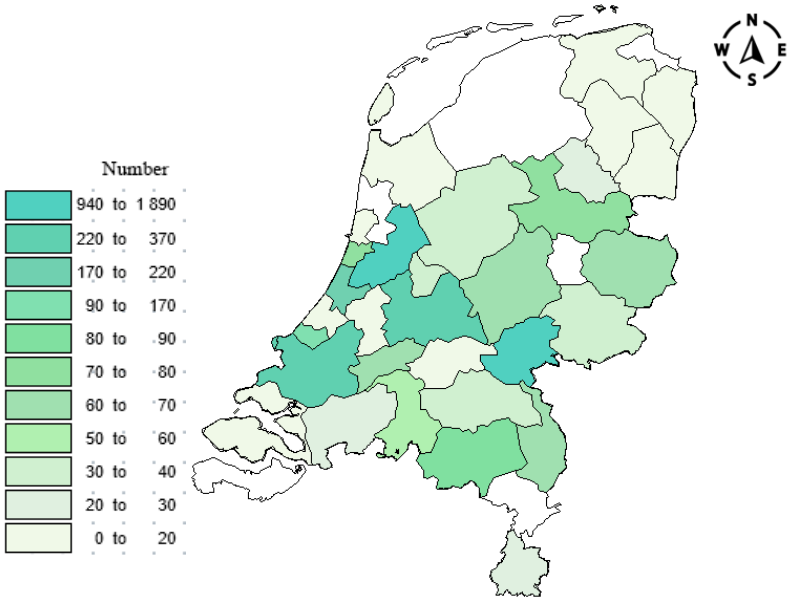

Figure 5. Number of cryptocurrency acceptance locations in The Netherlands, NUTS3 regional representation (Source: Self edited by own collection)

In the case of Spain, is shown in Figure 4, the larger cities provide the strength of each region. Mentioning Barcelona, Madrid, Málaga, Valencia, Palma alone evokes thoughts of tourism. In Madrid, those with cryptocurrencies are mainly welcomed in restaurants, of significant importance, but shopping venues are also significant categories. This indicates that gastronomic and shopping experiences are the key for cryptocurrency-shopping tourists in the region. The number of accommodation providers is also substantial, ensuring comfortable placement for tourists arriving in the city. Nightlife and cafés also play an important role in the aspect of cryptocurrency-accepting locations, indicating the city's dynamic and diverse cultural life. Barcelona is also prepared, with touristic services almost everywhere present in the aspect of acceptance of cryptocurrency, whether it is nightlife, food, or drink. The number of attractions is also significant in the context of digital coin acceptances, enhancing the city's touristic appeal. The transportation services. The most popular providers, such as Ultramarinos and Tollodaris, represent local flavours and the Barcelona lifestyle in the field of web 3.0 payment tools.

In Málaga, cafés lead, reflecting the southern Spanish lifestyle and the desire to relax. Shopping opportunities and transportation are also important, ensuring the comfort of tourists and easy access to the region in terms of cryptocurrencies. The top providers, such as El pequeño Buda - Tetería and the segway malaga experience, emphasize the local culture and the unique experiences offered to tourists, enhancing the legitimacy of the digital tourist.

In the Netherlands, shown by Figure 5, city-dominant regions are identifiable – Amsterdam, Rotterdam, Utrecht, The Hague, Eindhoven, Arnhem – but the acceptance of cryptocurrencies in rural, smaller settlements is not rare. The Netherlands is particularly strong in shopping and dining options regarding cryptocurrencies, an important attraction for tourists. The number of accommodation providers is also significant, indicating the strengthening of tourism infrastructure. The diversity of the Dutch tourism sector is reflected in the wide range of different types of services that meet the diverse needs of tourists. Based on the analysis, the strength of the Netherlands' tourism sector in the context of web3.0 payment tools lies in the diverse and quality services that attract international visitors. This is reinforced by the fact that among the top service providers are names such as StarBikes Rental, Jia, Snackbar 'De Hoefslag', Camping de Eendenkooi, and B&B De Haven. These service providers offer various services to the web 3.0 digital tourists, including bicycle rental, restaurants, snack bars, camping opportunities, and accommodation.

A peculiarity of the Netherlands is that the western regions are much more developed in terms of analysis, whereas in the north, the presence of crypto service providers is almost negligible compared to the total examination.

For the four selected countries, the establishment of a clustering neural network was justified to explore whether there are specific patterns in the grouping of categories at the settlement level. The clustering neural network analysis method, through SOM (Self-Organising Maps) and PCA (Principal Component Analysis), is suitable for examining the research question whether there are groupings of categories at the settlement level.

In this context, SOM and PCA serve as complementary methods in data analysis, particularly in this case, where data are provided by a big data file. We found both methods justified because SOM allows for clustering of data in a lower-dimensional space, aiding in the visual identification of patterns and groupings while preserving the topological properties of the data. This is reinforced by the linear transformation technique of PCA, which repositions the data in a new coordinate system where the variables (principal components) are independent. This enables dimensionality reduction without a significant loss of information. In the PCA process, the data is transformed to maximise variance, so the first principal component represents the greatest variance, the second the second greatest, etc. This helps identify the most significant patterns and trends in the data. For neural network analysis, the data was normalised, upon which the SOM was trained. During the training process, typographical errors were collected to examine how the error changes over iterations.

The Self-Organising Map (SOM) was trained on the normalised data over 1000 iterations. Figure 6. illustrates the SOM map (A.), where distances between different cells are represented by colour intensity (darker areas indicate greater distances). To interpret this, we also created a U-matrix (B) that represents the distances between the neurones of the SOM, as shown in Figure 6. to which we added the centroids of the clusters. These two maps help identify different clusters and their distances from each other. Identifying clusters helps to understand the data structure and the relationships between different categories.

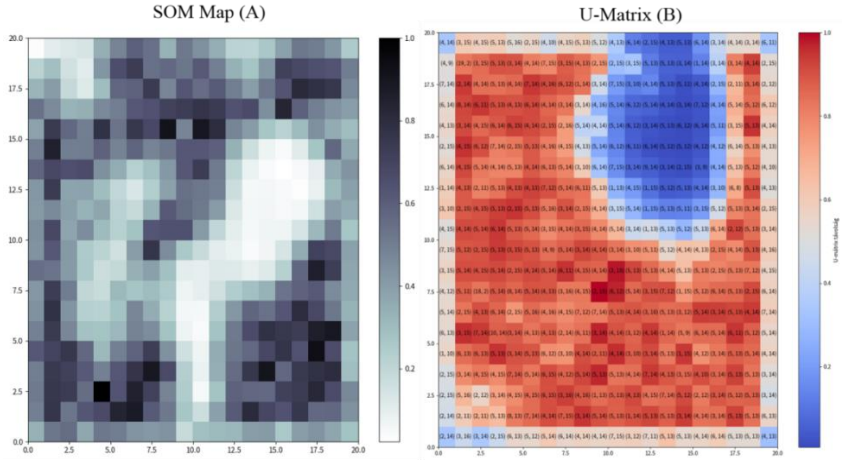

Figure 6. The SOM Map (A) and the U-Matrix (B) (Source: Output from own analysis)

During the categorization process, the neural network model divided data into 120 distinguishable categories. The Figure 7. illustrates the most common categories within the clusters. The "Item number" column indicates how many clusters feature the category as the most frequent one. As evident from the figure, the trio of nightlife, food, and lodging – categories directly related to tourism – collectively has the most significant influence in the clusters. This influence is not distorted by the shopping category, as both locals and tourists use the opportunities it presents. This is reinforced by the fact that typical local services - such as groceries and sports - and the categories with negligible presence on the diagram, such as ATMs and local services – greatly underperform in weight compared to the other categories. Reflecting on the research question, the data and methods used suggest that cryptocurrencies are used in tourism in the regions studied with significant intensity, and as shown in Figure 3, mainly during nightlife. During SOM clustering, input data (settlements and categories) were organised on a two-dimensional map, creating a data table with X and Y coordinates, where similar data points are located close to each other. Different arts of the map represent clusters, which denote groups of data. The most prominent groupings in terms of categories are as follows: Nightlife: 44 clusters; Shopping: 38 clusters; Food: 34 clusters; Lodging: 31 clusters; Transport: 5 clusters; Sports: 1 cluster; Grocery: 1 cluster. The notation "Nightlife: 44 clusters" signifies that the "Nightlife" category is the dominant category in 44 distinct clusters. A deeper examination of the data reveals that, according to the methods used in this study, cryptocurrencies are predominantly used in tourism in the regions examined, thus validating the H1 hypothesis.

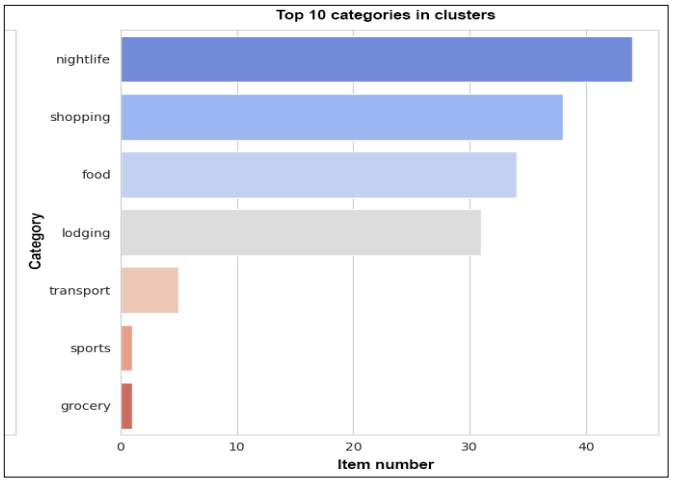

Figure 7. Summary diagram for category clusters (Source: Output from our analysis)

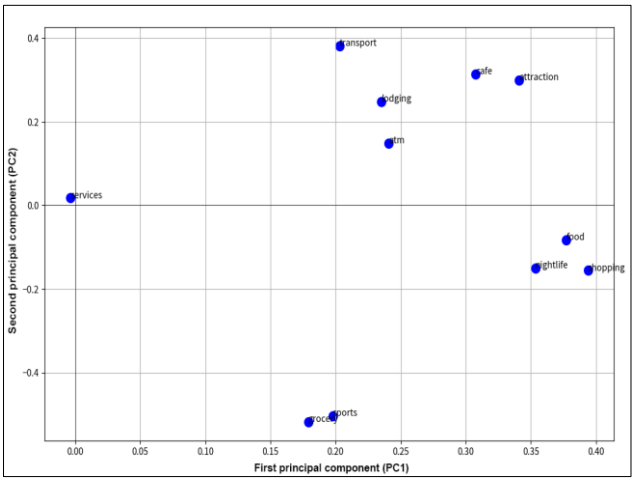

Figure 8. Loadings of the categories in the first two principal components, (Source: Output from our analysis)

To gain a better understanding of the clustering neural network, principal component analysis (PCA) was used, which involves creating linear combinations of the original variables. In our analysis, the first few principal components account for a significant portion of the data's variance. As we increase the number of principal components, the cumulative variance also increases, albeit at a diminishing rate. The first principal component alone explains a substantial part of the data's variance. However, as we increase the number of principal components, the increase in cumulative variance decreases, indicating that each additional principal component contributes less to the total variance.

Figure 8 illustrates the loadings of categories in the first two principal components. Categories located close to each other on the figure, such as "nightlife" and "cafe," show similar patterns across settlements, suggesting that places with a vibrant nightlife likely also have numerous cafes. This observation indicates regions where cryptocurrencies are more widely accepted in tourism. Categories situated further from the origin demonstrate greater loadings in a particular principal component. For example, the category „shopping" shows a substantial loading in the first principal component (PC1), indicating that shopping is a critical factor across settlements. This has implications for the tourism sector, suggesting that shopping opportunities with cryptocurrency play a significant role in tourists' choice of cities.

Categories near the origin exhibit lower loadings in both principal components, which implies that they contribute less to the explanation of variance in the data, such as sports or groceries. The wide distribution of categories in the figure indicates that settlements offer unique experiences in different categories. For the tourism sector, this means cities should diversify their offerings to attract various types of tourists. Based on the PCA results, the tourism sector could benefit from diversifying offers and leveraging connections between categories. For example, in a city where nightlife is popular, investing in cafes and restaurants could be advantageous. Similarly, enhancing shopping opportunities can be crucial, as they significantly influence tourists' city choices. Cities should also identify unique or exceptional categories to use in their tourism marketing.

This analysis not only strengthens the answer to our research question, but also confirms that, according to data and methods, cryptocurrencies are highly used in tourism in the studied regions. To demonstrate the correlation between cryptocurrency acceptance locations and tourism intensity and to examine our hypothesis H2, that the number of nights spent in tourist accommodations correlates with the number of cryptocurrency acceptance locations in the regions, correlation analyses were carried out. We interpreted the data at the NUTS 3 level, considering the number of guest nights spent in tourist accommodations as the dependent variable (Y) and the number of cryptocurrency acceptance locations in the NUTS 3 region as the independent variable (X). The consolidated data analysis yielded the following results:

Table 2. Correlation Table (Source: Output from our analysis)

	Value	**Lower 95%**	**Upper 95%**	**Signif. Prob**
Correlation	0.458693	0.332622	0.568658	<.0001*
Covariance	9.236e+8			
Count	174			

The correlation coefficient value of 0.458693 indicates a moderately strong positive relationship between the number of nights spent at tourist accommodations and the number of cryptocurrency acceptance locations within a country's NUTS 3 regions. It can be concluded that as the number of cryptocurrency acceptance locations in a region increases the number of guest nights generally increases as well. The 95% confidence interval indicates the level of certainty we have in the value of the correlation coefficient. In this case, we can say with 95% confidence that the true value of the correlation coefficient lies between 0.332622 and 0.568658. This means that even under the most pessimistic estimate, there is a positive correlation between the two variables. The p-value "<.0001" suggests that it is highly unlikely that the observed correlation coefficient occurred by chance. This implies a probable genuine relationship between the two variables, and not merely due to random fluctuations in our sample. The positive covariance value indicates that as one variable increases, so does the other, consistent with the positive correlation value. Based on these results, we can say that the number of nights spent in tourist

accommodations is positively correlated with the number of cryptocurrency acceptance locations in the country's NUTS 3 regions. As the number of crypto-accepting locations in a region increases, the number of guest nights typically increases as well. With these findings, we consider our hypothesis H2 to be validated, confirming that the number of nights spent in tourist accommodations correlates with the number of cryptocurrency acceptance locations in the examined regions.

CONCLUSION

In our research, we conducted a detailed analysis of the current status and potential impacts of cryptocurrency applications in the tourism industry in four examined countries. Our study paid special attention to key aspects highlighted in the literature, such as the application of digital payment tools in tourism and the economic impacts of tourism.

During our literature review, we tracked the global trends in cryptocurrency applications in tourism. Digital payment tools such as cryptocurrencies are increasingly gaining traction in the tourism sector, as supported by several studies. The application of cryptocurrencies in tourism not only diversifies payment methods but also offers new opportunities for the hospitality industry, such as reducing transaction costs and speeding up payment processes. Our research concluded that there is a moderate positive correlation between the number of cryptocurrency acceptance points and the intensity of tourism in the four countries studied. Using self-organising maps (SOM) and Principal Component Analysis (PCA) methods, we determined that cryptocurrencies in tourism appear primarily appear in accommodations, nightlife, and shopping centres. This correlation is particularly pronounced in Spain, France, the Netherlands, and Croatia.

The application of cryptocurrencies in tourism not only signifies a diversification of payment methods, but also opens new opportunities in the tourism sector, such as faster and simpler service for guests and promoting sustainable tourism. Additionally, cryptocurrencies allow for transactions without intermediaries, reducing costs and increasing transaction security. According to our research, the increase in the use of cryptocurrencies correlates with an increase in the number of nights spent in tourist accommodations, indicating that this payment method is increasingly accepted in the tourism sector. This trend could be particularly important for the digitalisation and sustainable development of tourism, especially in the countries we studied, where tourism is a significant economic factor.

Our research has several limitations that should be noted. The data on cryptocurrency acceptance points was not uniformly detailed or up-to-date, potentially affecting the results. The study focused on four countries—Spain, France, the Netherlands, and Croatia—limiting its generalizability to other regions. The analysis primarily examined accommodations, nightlife, and shopping centers, overlooking other sectors like transportation. Additionally, while self-organizing maps (SOM) and Principal Component Analysis (PCA) identified correlations, they did not establish causation. Finally, the findings represent a specific point in time, and the rapidly evolving nature of cryptocurrencies and tourism may lead to changes not reflected in this study. In conclusion, the growing acceptance of cryptocurrencies in tourism opens new opportunities for the sector, particularly in terms of digitalisation and sustainability. Our research highlights that the use of cryptocurrencies in tourism not only emerges as a new payment tool but also contributes to the transformation of the tourism sector.

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