The Importance of Blockchain for Ecomobility in Smart Cities: A Systematic Literature Review

Irénée Dondjio(✉)

University of Nicosia, Nicosia, Cyprus
dondjio.i@unic.ac.cy

Abstract. By 2050, cities will house at least 70% of the world's population. Already, metropolitan areas are responsible for 70% of all greenhouse gas emissions caused by energy usage. The expanding population of city dwellers has presented new challenges to contemporary urban areas. Congestion and other kinds of inefficient urban movement irritate city people and reduce their quality of life. Cities are reducing carbon dioxide emissions in an attempt to prevent global warming, which necessitates innovative new modes of transportation. Smart cities are innovative problem-solving projects for difficulties that have evolved as a consequence of increasing urbanization and changing environmental circumstances. Today's cities depend largely on people's capacity to travel freely and easily in order to minimize traffic congestion, provide a high quality of life for residents and tourists, and reduce carbon emissions and environmental deterioration. Everything is dependent on an effective and sustainable transportation infrastructure. Blockchain technology is being researched for smart city applications and is used in smart mobility for ridesharing, electric charging, platoon member interactions, and vehicle communication. Although exploratory research on this issue exists, it is spread over different use-cases and applications. This research conducts a thorough analysis of the literature on the implications of blockchain for smart city mobility and transportation, as well as its potential to boost efficiency in these sectors. The goal of this article is to synthesize and summarize existing information on the issue and contribute to closing the knowledge gap by researching how blockchain technology might improve ecomobility by reducing pollution, travel time, and congestion. The results of the literature review are divided into six use-case categories.

Keywords: Ecomobility · Smart Mobility · Blockchain · Smart Cities · Smart Contracts

1 Introduction and Research Problem

Rising pollution levels, the severe repercussions of climate change, and global warming are pressuring large cities to lessen the environmental impact of their means of transportation. According to an United Nation (UN) report, urban areas have a significant influence on the environment as they account for 67–76% of CO2 emissions and the amount of

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energy used. At the same time, metropolitan regions housed 55% of the world's population in 2018. It is anticipated that by 2050, this proportion would have increased to 70% (UN 2020). There are millions of vehicles on the road at any one moment, with devastating consequences for both the people who live there and the environment. In reality, transportation in all of its forms is responsible for the vast majority of the dangerous gas emissions generated in cities. In fact, transportation is responsible for around 26% of greenhouse gas emissions, with personal automobile trips contributing significantly (WHO 2019). Consequently, it appears that an ecologically friendly and intelligent transportation system is the promising way to address these issues Morris (2015). There is evidence that, although traffic is required for flexible movement within cities, it is harmful to people's wellbeing Morris (2015). Morris' study also discovered a substantial positive relationship between city life satisfaction and traffic time. Consequently, travelling time is important in cities and whole nations, and traffic has a definite detrimental impact on inhabitants' quality of life (Morris 2015). Urban areas are at the edge of smart and environmentally friendly transportation, embracing technology and policies to reduce carbon emissions from transportation, ease traffic congestion, and enhance air quality (Karger et al. 2021). Walking, public transportation, and cycling reduce pollution and promote sustainable mobility. Ecomobility supports practical, low-pollution, eco-friendly mobility and living conditions in local areas and municipalities. For a sustainable transportation, people should be prioritized and provided with more affordable, accessible, healthier, and cleaner alternatives to their present mobility behaviors. Automated and networked multimodal transportation, as well as smart traffic control technologies enabled by digitalization will play a growing role (Williams et al. 2012). Furthermore, the price of transportation should reflect its environmental and health effect. Transportation solutions are often tied to three primary concerns: urban sprawl, climate change, and equitable access to services and employment. Transportation, as previously noted, contributes considerably to CO2 emissions, and solutions may range from technological to behavioral to financial to infrastructural improvements. The primary cause of urban sprawl is the dependence on the private vehicle as the primary source of transportation (Woodcock et al. 2007). As result, the concept of smart cities emerged to solve economic and ecological concerns of the 21st century. A smart city improves people's quality of life and services by merging breakthrough technologies and new urban infrastructures (Batty et al. 2012). In fact, breakthrough technologies such as blockchain are developing at a tremendous speed. Blockchain technology excels in the efficient management of financial transactions. Its administration is completely decentralized, therefore there is no need for a central authority. According to Lopez and Farooq (2018), the great potential that blockchain has in the context of smart mobility has already been shown by research on smart cities and blockchain. For example, the technology may secure people's personally identifiable information on their mobility and defend their privacy (Lopez and Farooq 2018). Nevertheless, in spite of the preliminary work that has been done in this field, the studies are still disjointed and only seldom properly integrated.

The central aim of this paper is to help bridge the above mentioned gap by investigating how blockchain technology might enhance ecomobility by lowering pollution, travel time and congestion in Smart Cities. As a result the structure of this paper will be as follows: literature review, systematic literature revue, key findings, conclusion and discussion.

2 Literature Review

2.1 The Blockchain Technology

Blockchains are databases that record and preserve the transactional history of the data they were created to hold. It consists of interconnected “blocks” of data that cannot be altered after they have been added to the chain (Dondjio and Themistocleous 2022). The blockchain technology is sometimes referred to as digital ledger technology (DLT). This is due to the fact that it stores vast volumes of transaction information in a digital format on its ledger (CB Insights 2021). The introduction of cryptocurrency markets has contributed to the growing popularity of blockchain technology, illustrating how this innovation has the potential to shake up the financial industry.The characteristics of being decentralized, consensus-based, digital, immutable, chronological, and time-stamped have brought blockchain technology a great deal of notoriety (Deloitte (2017). As a result of these characteristics, blockchain has the potential to enhance a variety of aspects of the business environment, including as the reduction of risk, the visibility of supply chain activities, the eradication of fraudulent transactions, and general transparency (Teoh 2022).

2.2 Key Blockchain Characteristics

The most important features of blockchain technology are described in the subsequent paragraphs.

Traceability lets users trace blockchain transactions. Users may learn crucial transaction information by checking a data block. To monitor data, each system block is closely linked to the next one. ***Transparency*** allows system members to see and manage transactions. Members may publish transactions they enter into the system.It also detects and rejects questionable transactions. By letting stakeholders choose what data to send via a network, the system improves openness and security. ***Security*** is ensured by preventing outsiders from changing network data without consent. Blockchain transactions are guaranteed by ***immutability*****.** The system stops users from removing or modifying validated transactions. Blockchain technology avoids system failure and builds stakeholder ***trust***. (Dondjio and Themistocleous 2022).

The ***blockchain trilemma*** states that it is impossible to simultaneously maintain decentralization, security, and scalability in a distributed ledger system. One of these three properties is sacrificed whenever one of the elements is improved. Decentralization refers to the fact that a blockchain network does not depend on centralized points of control; security refers to the fact that a blockchain network can withstand and repel DDoS attacks; and scalability refers to the fact that it can manage enormous numbers of transactions (Teoh 2022).

2.3 Blockchain and Smart Contract

A smart contract is a self-executing contract in which the conditions of the buyer-seller agreement are directly encoded into lines of code. The code and the contract's agreements live on a decentralized and distributed blockchain network. Smart contracts enable anonymous parties to enter into trustworthy agreements and transactions without the requirement for a governance, legal system, central authority, or external enforcement mechanism (Antonopoulos and Wood 2018).

The creation of a smart contract may be accomplished on a number of different platforms, but one of the more prominent ones is Ethereum (Antonopoulos and Wood 2018). On the Ethereum platform, smart contract developers are free to create any decentralized application (DApp) of their choice. The decentralized programs execute precisely in accordance with the criteria specified in the code and do not run the danger of being censored, tricked, or experiencing downtime. Figure 1 depicts the execution process of a smart contract on the Ethereum network. Two parties achieve an agreement, which is then written in solidity code by a developer. The code is subsequently compiled to bytecode for processing by the Ethereum Virtual Machine (EVM). The participation of miners is essential for the contract to be processed on the blockchain. Once included, the contract is processed on the event date specified by the supplied code. The contract's execution releases payment to the relevant party, which may subsequently be confirmed by everyone (Sayeed et al. 2020).

2.4 Ecomobility and Smart Mobility

Ecomobility is a strategy for establishing and managing local regions and towns that promotes practical, low-pollution, environmentally friendly mobility and living conditions (Portillo 2018). Walking, public transit, and cycling are often confused with ecomobility. These three actions reduce pollution and promote environmentally friendly transportation. Ecomobility, also known as "smart mobility" or "sustainable mobility" is an example of an eco-innovation that involves responding to the needs of consumers and gaining their support (also known as "demand-pull innovation"); at the same time, however, it also involves asking which business ecosystem is most likely to provide efficient solutions to these needs (also known as "technology-push innovation") within the context of an institutional setting that is constantly changing (Boennec 2018). The concept "sustainable transportation and street mobility" refers to the wide issue of sustainable transportation in regards to its social, environmental, and economic implications (Beaume and Midler 2009). Sustainable transportation systems benefit the communities they serve in terms of environmental, social, and economic well-being (Dias et al. 2013). Many factors are considered when determining sustainability, such as the vehicles used, the source of energy, and the existing infrastructure supporting transportation, transportation operations and logistics, and transit-oriented development (Litman 2017). Eco-mobility allows cities to access goods and services in a sustainable way. It improves urban quality of life, expands sustainable travel options, promotes social cohesion, reduces greenhouse gas emissions and congestion, improves air quality, provides equitable transit options, boosts local green economies, and improves cyclist safety (Portillo 2018). To respond to rising pollution levels, the severe repercussions of climate change, the environmental and global warming effect of cities requires eco-friendly and sustainable action (Lauwers et al. 2025). To preserve economic development and quality of life, smart cities invest in human and social capital, transportation and ICT infrastructure, and democratic government. Smart towns reduce traffic congestion. Self-driving automobiles and sensors for urban infrastructure are options (Dameri 2017). Smart mobility, a component of smart cities, employs technology and approaches to improve transportation sustainability and efficiency by reducing pollutants, travel times, traffic, accidents, and urban footprint (Giffinger et al. 2007).

3 Systematic Literature Review

The purpose of this research is to map the state of the art in published papers on the use of blockchain for fostering ecomobility in smart cities by using elements such as novelty, drivers, models, and methods. Moreover, the research is based on an understanding of a variety of topics, including people and technology and challenges around the blockchain adoption. The Systematic Literature Review (SLR) technique will be divided into three (3) components, as illustrated in Fig. 1. At the first step (planning phase), the researcher realizes the need for an SLR and develops and tests a review approach. In the second step (conducting phase), the study sought for and collects primary studies, and data is collected and analyzed. The last stage (report phase) focuses on synthesizing the information obtained in earlier phases in order to communicate the results.

3.1 Planning Phase

- **Identifying the Research Question and goals for the review**

Given the significance of blockchain's potential usage in many industries, a systematic literature analysis was conducted to identify current research as well as possible use of blockchain technology for ecomobilty in smart city. To accomplish this goal, the following research question has been identified: **"How could blockchain technology be used to foster ecomobility in smart cities?"**

- **Identifying Keywords and Search Queries**

The keywords used to guide the search process were *"Blockchain"*, *"Smart Mobility", "Ecomobility" and "Smart City"* (Table 1)

Table 1. Keywords and Search Queries

Key Words	Search Queries
Blockchain	Query-1: "Blockchain" AND" Smart Mobility"
Smart Mobility	Query-2: "Blockchain" AND "Ecomobility"
Ecomobility	Query-3: "Ecomobility "AND "Smart Mobility"
Smart City	Query-4: "Ecomobility "AND "Smart Smart City"

3.2 The Conducting Phase

- **Literature Selection**

A thorough search of the databases such as: JSTOR, EBSCOhost, IEEE Xplore Digital Library, ScienceDirect, and SpringerLink yielded a total of 1250 papers, with the "Preferred Reporting Items for systematic reviews and Meta-Analyses (PRISMA)" directing the researchers to identify, filter, and choose the most relevant material. The articles were imported into "Endnote," where they were combined, verified, reassessed, and corrected, and duplicates were removed all at once. The inclusion and exclusion

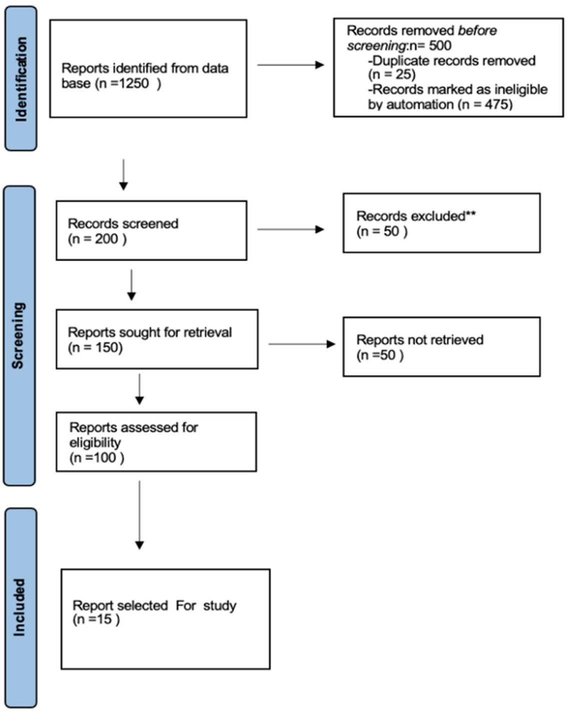

Fig. 1. Prisma framework for a SLR

criteria were applied to further filter and choose the most relevant articles while excluding those that were not (Table 2).

- **Inclusion and Exclusion Criteria**

Table 2. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion criteria
Peer review studies only	Grey literature
Academic	White papers and Non-academic papers
Full text only	Full text not available
English language	Non-English
Published on 2016 onwards	Published before 2016
Within the study scope	Diverged from the study scope

- **Study Screening, Selection and Data Extraction**

A manual scan of the references lists from the chosen papers was undertaken to ensure a thorough selection, and relevant additional articles were rechecked and included. Many abstracts and titles were obtained among numerous publications to determine whether or not the content was related to this investigation. In all, 150 studies were selected, and their full-texts were reviewed, downloaded, and re-evaluated in light of the inclusion and exclusion criteria. This approach further decreased the findings, and 100 papers that met the inclusion criteria were referred to the "Critical Appraisal Skills Programme (CASP)" for quality assessment. The majority of the papers were rejected because they did not match the inclusion criteria. After final rechecking, 15 studies were chosen for this evaluation.

3.3 Reporting Phase

- **Selected articles for the study**

Table 3 summarizes the articles chosen for this analysis based on the approach of Brereton et al (Brereton et al. 2007). The first column includes the research paper's authors, the second column lists the research piece's title, and the third column briefly summarizes the study work's emphasis.

Table 3. Articles selected for the study

Authors	Titles	Subject's Goals and Summary
Chang and Chang 2018	Application of Blockchain Technology to Smart City Service: A Case of Ridesharing	This article creates a decentralized blockchain using SmaRi. The technology offers users automatic execution, an immutable record, and decentralized decision-making. Peer-to-peer trades may support the sharing economy. Authors connect SmaRi to management systems. SmaRi may build functionalities by connecting to the original system. This study may advance smart cities
Huang et al. 2019	NSC: A Security Model for Electric Vehicle and Charging Pile Management Based on Blockchain Ecosystem	This study presents a decentralized blockchain security paradigm based on the lightning network and smart contract (LNSC). Registration, scheduling, authentication, and billing are included. The new security model can be simply incorporated with existing scheduling techniques to improve EV-charging pile trading. This study presents actual experimental findings. These data show that our strategy improves vehicle security
Baza et al. 2019	B-Ride: Ride Sharing With Privacy-Preservation, Trust and Fair Payment Atop Public Blockchain	B-Ride introduces a time-locked deposit scheme for ride-sharing using smart contracts and zero-knowledge set membership evidence. Drivers and riders must establish good faith by paying a deposit to the blockchain. Later, a motorist must confirm to the blockchain that he/she arrived on time. To protect rider/driver privacy, zero-knowledge set membership proof is used. To guarantee equitable remuneration, pay-as-you-drive is based on driver and rider distance. A reputation model rates drivers based on their prior behavior
KIM, 2019	Impacts of Mobility on Performance of Blockchain in VANET	This paper presents a paradigm for analyzing the influence of mobility on a blockchain system's performance in a VANET based on three critical metrics: the chance of a successful block addition, the stability of a rendezvous, and the number of blocks exchanged during a rendezvous. Closed-form expressions and numerical data show blockchain performance in VANET situations
Nguyen et al. 2019	Blockchain-Based Mobility-as-a-Service	Since public and private transportation companies must connect to this layer for MaaS to work, we suggest a blockchain-based MaaS to remove it. The approach promotes confidence and transparency for all parties and removes the need for separate MaaS agents. Computing power and resources are given to transportation providers at the network's edge, creating decentralized trust. The blockchain-based MaaS might become the key component of smart city mobility, lowering CO_2 emissions

(*continued*)

Table 3. (*continued*)

Authors	**Titles**	**Subject's Goals and Summary**
Zhang and Wang, 2019	Data-Driven Intelligent Transportation Systems: A Survey	The availability of a huge quantity of data may lead to a revolution in ITS development, converting a traditional technology-driven system into a more powerful multifunctional data-driven intelligent transportation system (D 2 ITS). D 2 ITS is becoming a more intelligent, privacy-aware system
Chen et al. 2020	Smart-Contract-Based Economical Platooning in Blockchain-Enabled Urban Internet of Vehicles	This article proposes platoon-driving for autonomous cars in free-flow traffic to enhance urban traffic and prevent accidents. This concept groups path-matched vehicles into a platoon directed by the platoon leader (PH). A PH selection method is established to encourage cars to be PHs and sustain platoon dynamics. Next, a smart contract enables blockchain-based payments between the PH and PMs, eliminating harmful and misleading payments. The platoon model consumes less gasoline than the solo model
Yuan and Wang 2016	Towards blockchain-based intelligent transportation systems	Blockchain might change centralized ICT systems (ITS). Blockchain can provide a safe, trustworthy, decentralized autonomous ITS environment, strengthening legacy infrastructure and crowdsourcing. Blockchain ITS (B 2 ITS). The paper proposes a seven-layer ITS-oriented blockchain architecture to solve B2 ITS research concerns. The paper examines blockchain's use in parallel transportation management systems (PtMS) Ride-sharing blockchain case study concludes the investigation. This study aims to encourage more B2 ITS research
Aujla et al.2020	BloCkEd: Blockchain-Based Secure Data Processing Framework in Edge Envisioned V2X Environment	This proposes a blockchain-based safe data processing platform for edge V2X. (hereafter referred to as BloCkEd). A multi-layered edge-enabled V2X system model for BloCkEd is provided with a multi-objective optimization problem. BloCkEd uses efficient container-based data processing and blockchain-based data integrity management to reduce connection breakage and latency. We execute and analyze the suggested technique in Chandigarh, India, for latency, energy usage, and SLA compliance

(*continued*)

Table 3. (*continued*)

Authors	Titles	Subject's Goals and Summary
Ying et al. 2020	BEHT: Blockchain-Based Efficient Highway Toll Paradigm for Opportunistic Autonomous Vehicle Platoon	Blockchain-based highway tolls are proposed for the opportunistic platoon. The blockchain records and verifies every registered vehicle's driving history. A roadside unit (RSU) distinguishes a single vehicle from a platoon and allocates lanes. An aggregate signature speeds up RSU authentication. This scenario's security risks are analyzed. The experiment shows that our strategy works well
Lei et al. 2017	Blockchain-Based Dynamic Key Management for Heterogeneous Intelligent Transportation Systems	This paper introduces heterogeneous network key management. Security managers (SMs) record vehicle departure information, encapsulate block-to-transport keys, and rekey automobiles within the same security domain. First, a blockchain-based decentralized network. Blockchain may simplify VCS distributed key management. Second, dynamic transaction collection reduces vehicle handover time. Extensive simulations and analysis show the framework's effectiveness. The blockchain structure transfers keys faster than the structure with a central manager, and the dynamic approach allows SMs to meet shifting traffic volumes
Hawlitschek et al. 2018	The limits of trust-free systems: A literature review on blockchain technology and trust in the sharing economy	This paper analyses how blockchain technology might tackle the trust problem in the sharing economy. By conducting a dual literature review, the authors found that 1) the conceptualization of trust differs between blockchain and the sharing economy, 2) blockchain technology is suitable to replace trust in platform providers, and 3) trust-free systems are hardly transferable to sharing economy interactions and will depend on the development of trusted interfaces for blockchain-based sharing economy
Kim et al. 2021	Design of Secure Decentralized Car sharing System Using Blockchain	Traditional car-sharing is centralized, so there's a single point of failure. Decentralized car-sharing is key to overcoming the centralized dilemma. This research created a blockchain-based car-sharing system. Blockchain was utilized to decentralize car-sharing and assure data integrity. Anonymous authentication is possible for system participants. The suggested car-sharing system may be protected against assaults utilizing informal analysis, AVISPA simulation, and BAN logic analysis. The suggested scheme's computing and communication costs were studied

(*continued*)

Table 3. (*continued*)

Authors	Titles	Subject's Goals and Summary
Dungan and Pop 2022	Blockchain-based solutions for smart mobility sustainability assurance	Blockchain, recognized for its relation to bitcoin and other cryptocurrencies, may suit ITS safety and security needs (ITS). This technology can store information securely, protecting it from security concerns. This streamlines and secures TMCs' sensor network data processing (Traffic Monitoring Centers). Cyberattacks may create erroneous traffic signal phases and green-interval settings at junctions. The results will be based on a comparison with existing IoT techniques for securing sensor traffic data
Orecchini, et al. 2018	Blockchain Technology in Smart City: A New Opportunity for Smart Environment and Smart Mobility	Smart Cities use people-centered digital initiatives that lead to high-tech breakthroughs to develop capacity and opportunity. This paper investigates the possibility of integrating the innovative and multi-purpose Blockchain Technology in the smart city evolutionary process, and in particular in the Smart Environment and Smart Mobility by allowing renewable energy source traceability and by providing information about the kind of energy used to refuel, for example, the selected vehicle. More user knowledge of environmental and energy sustainability is projected

4 Key Findings

The majority of the articles studied pointed the great potential that blockchain has in the context of Ecomobility and smart mobility. According to the findings, the blockchain technology is suitable for the implementation of a decentralized trust management system in automotive networks because of its decentralized nature, its transparency, and its inalterability. In addition, payments for parking and public transportation may be processed faster using blockchain-based transactions. The key findings of this study are presented below.

Finding-1: Sustainable Mobility System Model

Dungan and Pop (2022) provide a conceptual model for a sustainable smart transportation system that incorporates blockchain technology. Their model takes into account the Smart Sustainable City-Blockchain (SSCB) integration architecture and emphasizes its advantages in the transportation area. In addition, transportation energy management has been incorporated as an indication. The model (see Fig. 2 below) also reveals a particular interest in green transportation systems integrating intelligent energy consumption control and CO_2 emission reduction. Blockchain technology is being developed with the intention of delivering appropriate solutions for car-sharing services in terms of both privacy and security. In addition, payments for parking and public transportation may be processed faster using blockchain-based transactions, with the only limiting factor being the amount of traffic on the network (Dungan and Pop 2022).

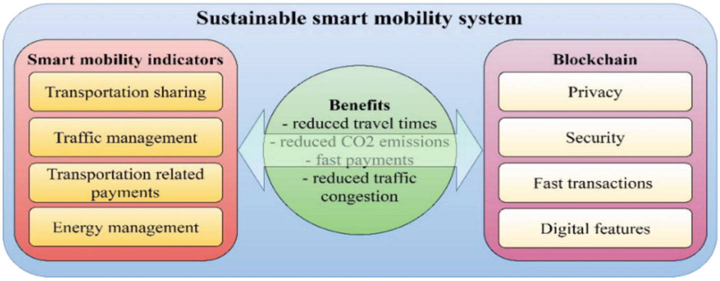

Fig. 2. Sustainable Mobility System Model by (Dungan and Pop 2022)

Finding-2: Intelligent Transportation Systems (ITS)
Yuan and Wang (2016) highlight that Intelligent Transportation Systems (ITS) have emerged with the goal to apply several advantages to mobility, like improving travel security and increasing the performance of transportation systems. In addition, ITS enables smart vehicles to communicate with each other and access the internet. The authors take a broader perspective and propose a blockchain-based ITS model. As they believe that the advantages of blockchain models like decentralization, security, and trust make it highly suitable for such a purpose (Yuan and Wang 2016). Proposes a blockchain platform architecture (Fig. 3 illustrates ITS architectural layers).

The physical layer contains physical objects like cars, traffic lights, or devices. ***The network layer*** ensures data forwarding, verification, and distributed network establishment. ***The incentive layer*** describes the production and distribution of economic incentives in blockchains to drive network members to continue mining and verifying transactions. ***The contract layer*** is the basis for smart contracts, which ITS uses to manage and program physical and digital assets. ***The application layer*** shows ridesharing, logistics, and asset management.

Finding-3: Vehicular Communication Systems (VCS'S)
Aside from the underlying architecture of ITSs, another component of smart mobility where blockchain might aid is vehicular communication. Vehicles may interact with each other (Vehicle-to-Vehicle, V2V) and with the infrastructure (Vehicle-to-Infrastructure, V2I), according to Cooperative-Intelligent Transportation Systems (C-ITS), as illustrated in Fig. 4. This broadens each vehicle's awareness of its surroundings and has fostered the creation of new productivity, safety, and entertainment applications, which are the foundation of the future C-ITS ecosystem (Javed and Hamida 2017). But these advances have been focussed on traditional cars, overlooking personal mobility options that are changing urban settings. Many people use bicycles, scooters, and electric motorcycles since they're eco-friendly and healthful. Lei et al. (2017) suggest that, despite recent advancements, VCSs still face vulnerabilities and concerns related to security and key

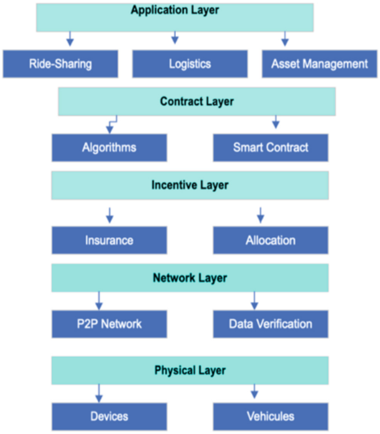

Fig. 3. An ITS-Oriented blockchain model (adapted)

management. As a result, the authors suggest a blockchain-based key-management strategy for securely sharing keys for communication across multiple devices or vehicles. Network members may use the blockchain-based technique to collect the trust values of other network participants and, based on this, assess the trustworthiness of received messages.

Finding-4: Carsharing

Consider that you and your colleague are neighbours with automobiles posted on a carsharing platform. He is out of town, and your children need a vehicle. Instead of driving your vehicle home from the workplace, you might reserve his vehicle at his residence. While the underlying technology is unclear, well-known entrepreneur Elon Musk has discussed developing a comparable idea, which he calls the "Uber-killer." Nowadays cab services are accessed using a smartphone app. Due to government anti-pollution programs, increasing taxi charges, and the decreased demand for personal automobiles owning to remote work, the worldwide car sharing industry is expected to grow. Europe carsharing market size is expected to cross $4 billion valuation by 2024 (Graphical research 2021). However, car sharing may encounter trust issues between customers and car owners along with some security concerns.

The confidence that individuals place in one another as well as the faith that individuals place in the platform itself are two aspects of trust that are of special significance in the context of the sharing economy. First, having faith in one's contemporaries involves having faith in one's own customers and producers (Hawlitschek et al. 2018). Therefore, in the context of mobility, what this is referring to is the trust that exists between the riders and the drivers. Hawlitschek et al. (2018) went on to suggest that there is a connection between trust in the platform and trust in the platform for the sharing economy. To the best of our knowledge however, trust in the context of ridesharing based on blockchain technology has not yet been investigated at this point in time. Because faith in the platform as well as trust in one's fellow users is a vital component of the sharing

Fig. 4. Urban fully-connected vehicular scenario.: V2V/V2I links (Javed and Hamida 2017).

economy, it seems that this is one of the most significant research gaps that Blockchain technology might assist in addressing.

Finding-5: Smart Contracts Connecting Stakeholders

To ensure that clients are not overcharged and car owners are always compensated for rentals, (Kotik and Serhii (2022) developed a reliable blockchain model for car sharing (see Fig. 5). In this basic smart contract example, they demonstrated that payment may be flexible: the user simply pays for the time spent using the automobile, and income is sent straight to the car's balance. Car owners are always rewarded when their vehicles are utilized since the customer's deposit payment is locked in before the rental begins. On the event of an accident, the car owner will know who was driving since information saved in the blockchain cannot be modified and may be shared with other parties such as insurance companies. According to Kim et al. (2021) people may now simply utilize a shared automobile by performing basic operations on their mobile devices thanks to the growth of the Internet of Things. The car-sharing program, however, has security issues. Sensitive data is communicated for car-sharing on a public channel, including the user's identity, location data, and access code (Kim et al. 2021).The suggested car-sharing authentication approach proposed by Kim et al. (2021) uses blockchain with five entities: trust authority, stations, owner, vehicle, and user. A trust authority sets up the system and gives user credentials and pseudo-identities. Stations arrange the consortium blockchain with data storage and compute. The user requests car-sharing via the station. After authentication, the user gets the vehicle access code.

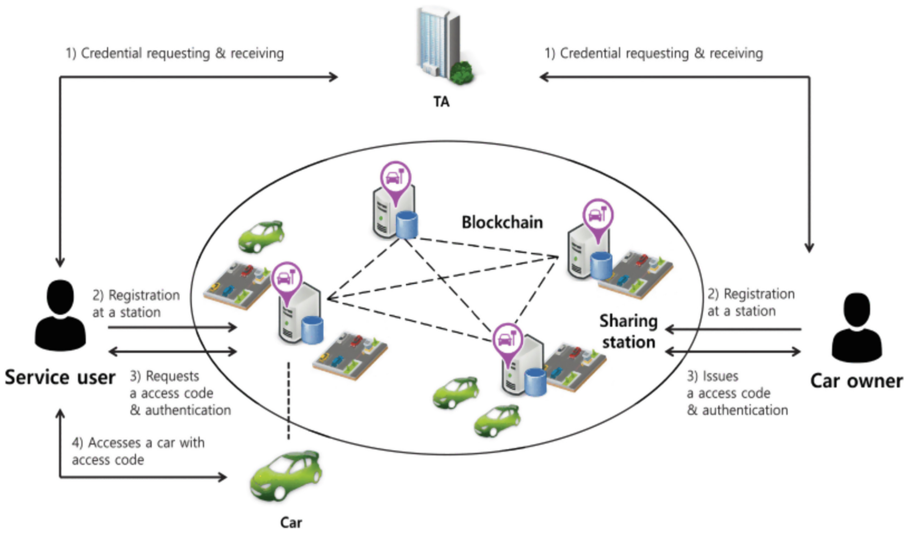

Fig. 5. The proposed system model by (Kim et al. 2021)

- **Trust Authority (TA)** - A trust authority is responsible for the initial setup of the system as well as the distribution of user credentials and pseudo-identities. Data storage and processing are handled by the stations that make up the consortium blockchain. The station receives a request from the user for carsharing. The user is given the vehicle access code after they have been validated.
- **Stations** - Stations arbitrate between car-sharing users and vehicle owners. The station gets the user's and owner's car-sharing credentials. The station validates and keeps credentials on blockchain. When a user requests car-sharing, the station authenticates them using blockchain data. It offers car-sharing by communicating owner information. The station saves service information in blockchain, which the trusted authority may utilize to arbitrate disputes.
- **User** - smartphone users may access the car-sharing service. User sends request and authentication messages to station to verify driving authorization. The station authenticates users using blockchain data. After authentication and acquiring the vehicle access code, the user may use their mobile device.
- **Owners** - By registering their car at the station, the owner turns it into a shared vehicle. When the station delivers a user's request to share a car, the owner produces an access code and sends it to the station to distribute to the user and vehicle.
- **Cars** - At the station, authorized users may share parked cars. Automotive modules include communication and tamper-proofing.

The vehicle's communication modules send it an access code to verify whether the user is permitted. Vehicle parameters are kept in a tamper-proof module for confidentiality.

Finding-6: Fleet Management

Many Fleet Management solutions rely on real-time remote vehicle monitoring (Karger et al. 2021). When it comes to smart mobility, blockchain technology will make it possible for several stakeholders, such as an insurance company, a tax agency, and a road transport authority, to act at the same time. It is possible for users to submit their supporting documentation to participate in the platform's automobile listing service. These papers may be kept on a distributed database, and each party may independently validate the request and certify a vehicle's availability. It provides a trust-building and consensus management mechanism on an anonymous basis. The vehicle paperwork will go through approval when the majority of parties have acknowledged them, and then they will be able to be preserved as a smart contract (Orecchini, et al. 2018).

Driver Certification. Like car registration, driver identity management, driving license authenticity, and other key papers might use a similar document approval and listing system. To take a nearby parked automobile, submit your license for verification. If the documents are legitimate, they may be preserved as Smart Contracts with immutable data (Orecchini, et al. 2018).

Security. Decentralized databases are safe and unchangeable. Imagine a motorist taking someone else's automobile. Every automobile owner whose car has been rented keeps the same database. Every transaction is confirmed and acknowledged (Orecchini, et al. 2018).

5 Conclusion

In terms of transportation, the previous several years have seen some progress towards future smart cities. Population growth affects urban mobility since cities were built decades or centuries ago with a much lower population and distinct infrastructural demands. The evolution towards cities and smart mobility will not involve making more space for vehicles or more roads; rather, it will undergo a cultural paradigm shift in which people will stop using their private cars and switch to shared transport, which may reduce the number of vehicles in circulation and the ecological footprint. In addition to the technology challenge, we also have a very obvious cultural shift since using our own automobiles provides comfort and convenience that won't be simple to give up. Citizens must comprehend the severe environmental repercussions of preserving the existing situation and the difficulties of managing so many automobiles in high-density cities. We will all benefit from this cultural and paradigm change.

People need inexpensive, accessible, healthier, and cleaner alternatives to their current mobility practices for sustainable transportation. Digitalization will boost automated and networked multimodal transportation and smart traffic management technology (Williams et al. 2012). Transport prices should reflect environmental and health impacts. For the completion of this paper, the author conducted a systematic literature review on blockchain's usage in smart mobility and transportation. 15 selected papers were examined to address the research question, and the use of blockchain technology in the ecomobility and smart mobility was identified. An analysis of the existing research literature indicates that there are five major primary categories of blockchain applications that may be used for the benefit of smart mobility, and these categories are as follows: Sustainable Mobility System (SMS), Intelligent Transportation Systems (ITS), Vehicular Communication System(VCSS), Carsharing, Fleet Management.

6 Discussion

As mentioned in this paper, Blockchain will be the next revolutionary smart transportation technology in coming years. However the privacy of the data related to their brief trips and the overall GDPR compliance of the Smart Mobility Solution will be the main concerns of the public. The stability, performance, and usability of the side chain's elements, such as payments and real-time location data services, are still ambiguous at this point. A few use-cases has already been addressed by researchers.

The environmental benefits of the proposed eco-mobility networks, such as energy efficiency and climate change mitigation and adaptation, are important, but community-based participatory urban renewal and landscape planning that involves local residents (commuters and users) in all decision-making is more crucial. Despite the initial work in this area, the studies are still fragmented and sometimes barely sufficiently integrated. This review aimed to closing this gap and providing an overview of the current state of the art in blockchain for ecomobility and smart mobility.

Despite the fact that the research addressed the primary issue, there are certain constraints to consider. To begin, the papers examined were restricted to those found in JSTOR, EBSCOhost, IEEE Xplore Digital Library, ScienceDirect, and SpringerLink. Second, despite the fact that this study utilized a wide list of keywords in major research databases, there is a risk of losing some essential work due to the dispersion in function of the keywords used in this area. Furthermore, the scalability and continuously evolving aspect of the blockchain technology remain significant issues, and there is a lack of work (for example, Framework) that combines the improvements offered by all research efforts. For instance it is expected that the number of nodes will expand fast, causing blockchain scalability concerns, and smart cars' bandwidth will be too low to handle the broadcasting overhead. Another issue could be that the algorithms sustaining the blockchain need more processing power than smart devices, thus there would be a large gap when using it in automotive businesses. Also smart contract adaptability may be another issue as many industries find it challenging to keep smart contract structure and standards because it contains so many hidden aspects that cannot be seen by rivals. An adaptive smart contract framework would be extremely beneficial. Furthermore, the application of blockchain in ecomobility and smart mobility, including testing, is still in its infancy. All of these results hint to a research gap and unanswered research problems that must be addressed further. As a result, there is a need for a more complete conceptual model that integrates, synthesizes, and orchestrates all key research works in an effective manner to aid people and/or organizations in the widespread adoption of blockchain.

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