DIVAIRCITY

The power of Diversity & Inclusion for Climate Neutral Cities

Requirements of the MSCCP and SCCCP

Deliverable 5.1 - Public

Lead Beneficiary: Blockchain Intelligence

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List of Acronyms

Acronym	Meaning
AB	Advisory Board
AQ	Air Quality
BC	Blockchain
CA	Consortium Agreement
D	Deliverable
dApp	Distributed Application
DID	Digital Identity Document
DLT	Distributed Ledger Technology
DoA	Description of Actions
DTS	Draft Technical Specification
DLT	Distributed Ledger Technology
EBSI	European Blockchain Services Infrastructure
EU	European Union
GA	Grant Agreement
GeA	General Assembly
ICT	Information and Communication Technologies
MSCCP	Main Smart City Contract Platform
PC	Protected Categories
PCU	Project Coordination Unit
SCCCP	Smart Climate City Contract Platform
SSI	Self-Sovereign Identity
UI	User Interface
WP	Work Package

Glossary

Term	Definition
Application	The User Interface of the MSCCP.
Blockchain Platform	The BC to be used, e.g., Ethereum, Alastria, EBSI.
Developer	Technical staff that works on the development and maintenance of the application.
Digital ID (DID)	Digital Identity is the twin of the identity of a person but in the electronic world.
Digital Wallet	Digital Wallet is the twin of the physical but in the electronic world.
eIDAS	EU Regulation 910/2014 of 23 July 2014 on electronic identification, better known as electronic Identification, Authentication and Trust Services regulation
Issuer	The Authority that issues the credentials of the users.
MSCCP	Main Smart Cities Contract Platform. Here, it stands for the overall system.
SCCCP	Smart City Climate Contract Platform. It is part of the MSCCP.
Smart Contract	Software programs which are executed when specified conditions are met.
SSI	Self-Sovereign Identity. A form of distributed digital identity.
User	The user of the application, citizen and member of the diversity groups.

This deliverable is intended as a live document during the project. ToR can change in the future months according to the deployment of the actions

1. Objective

An essential part of the DivAirCity Project is the design of technological platforms (defined as MSCCP and SCCCP) that help cities meet their goals regarding air quality (AQ) and reducing carbon footprints using NBS. These platforms will enable citizens' participation by a) facilitating the secure and efficient handling of citizens' data under the lens of diversity and equality and b) stimulating active and impactful participation by setting up a rewarding mechanism for citizens' contribution. This rewarding system will use blockchain-based solutions, including tokenisation, smart contracts and eventually self-sovereign identities, to motivate and benefit citizens for their contributions with full respect to privacy in the use of personal data.

Creating a blockchain-based MSCCP and SCCCPs is an opportunity for the cities to provide their citizens with a trustworthy, decentralised information system for monitoring air quality and decarbonisation efforts based on NBS while stimulating their collaborative contribution through an also decentralised rewarding mechanism.

The exact rewarding scheme for each city will be defined in the framework of the activities of the DivAirCity's *'WP2 - Digital Innovation and D&I Data Management Framework'* and *'WP3 - Participatory engagement and people-driven framework'*. It will result from a broader and inclusive cocreation exercise that addresses the requirements and needs of each city´s citizens, with an emphasis in the diverse groups of interest. In this respect, inputs by the activities related to the processes of *Data Management Framework specifications*, the *Ethics, privacy and security data management requirements* and the *Green Cities Index specifications*, as well as the *analysis on the concept Business Models* have been considered. Based on these inputs, the Smart Contracts and Tokenisation Models will be defined. These are the building elements of the SCCCPs, to allow the cities to achieve their sustainability goals within their own structures and with their Citizens.

The current document defines a solid set of fundamental requirements that will be used to define the blockchain-based SCCCPs and the MSCCP, including the rewarding model. It will also be used in the evaluation phase to guarantee that the basic established requirements have been met and respected throughout the implementation. These requirements aim at ensuring the highest quality standards based on the current status of technology. A special focus has been given to the following areas: a) technical standards, b) legal, governance, and ethical, c) user experience and user-friendliness, d) sustainability and diversity e) decentralised ecosystem building.

2. Methodology

The aim of this document is to define a set of high-level requirements that serve as a basis to guarantee that both the SCCCPs and MSCCP will deliver data and a rewarding system, which will be ready to enter the market. In that sense, analysing the current technology and market status seems essential and understanding the fundamental regulatory and political approach based on the latest developments at the EU level. At the same time, indicative scenarios have been identified through the Cities' DNAs. Since the beginning of the project, several meetings have taken place, and a questionnaire has been distributed to the Cities. The overall process led to the requirements presented in Section 5.

General research approach

A systematic knowledge review method has been facilitated, achieving an in-depth analysis, as shown in Figure 1.

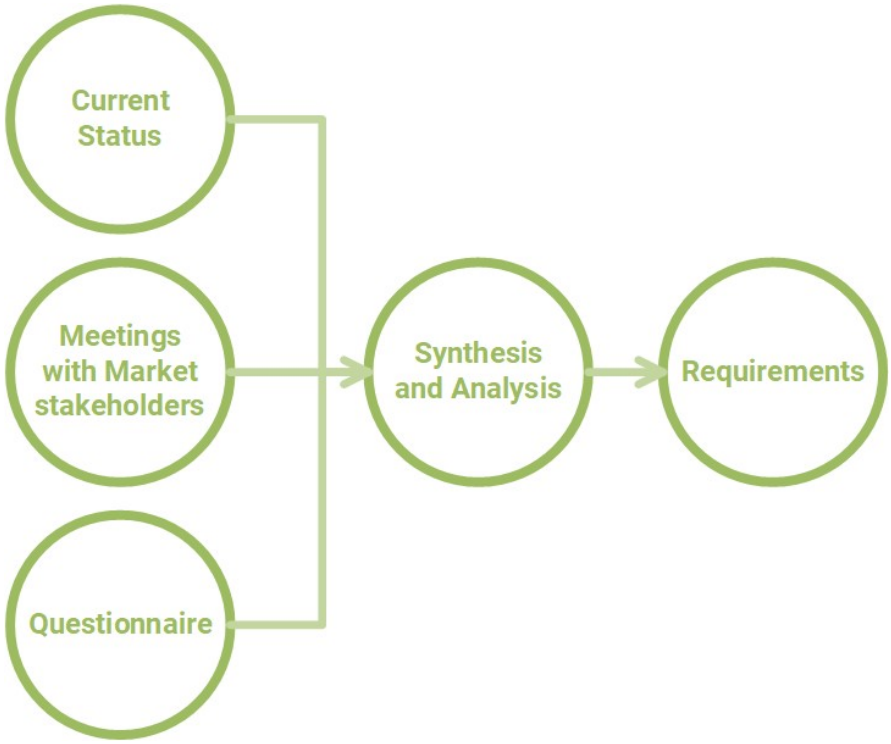

***Figure 1**. Mixed knowledge Review*

The research approach followed the next stages:

1. An extensive research based on technical literature has been performed. The review and analysis of existing applications refined the data and gave a more distinct insight into developments and trends closely related to the DivAirCity targets.

2. Specific research and meetings with reputed experts in Blockchain/DLT have been to identify the market, political and regulatory stand that directly relates to the DivAirCity objectives and identify specific challenges. A special focus has been given to developments in the EU.
3. A questionnaire has been sent to the Cities focusing on their current status in using Blockchain/DLT, self-sovereign identity models and citizens rewarding systems. The questionnaire has been created, including questions related to all WPs. Thus, an overview of the cities' status has been provided and examined, even for D5.1.
4. The Synthesis of the above results resulted in defining the requirements.

3. Overview of the status of Blockchain applications

A thorough overview regarding the current status of Blockchain applications has been systematically pursued. A triple approach has been applied to market research and use cases. First, we have searched for blockchain-based uses cases related to sustainability. Next, we looked for solutions that foresee any reward. Finally, we specifically searched for blockchain-based cases related to cities and public administration. These use cases provide different perspectives to our broad and diverse goals.

As a result of this comprehensive review, aiming at tracing the current situation on using blockchain technology together with air quality and decarbonisation, a brief overview of the current state of BC implementations is presented.

The advent of BC and the Smart Contracts has raised the interest in its use in various use cases of a broad spectrum. Starting from cryptocurrencies [1] and spreading on improving security [2], handling health data [3], energy transactions [4], digital wallet [2], and others. Recently, special focus has been drawn on sustainability [5], [6], air quality and decarbonisation [7].

The scope of the first part is to discuss the current status on air quality and decarbonisation, providing indicative examples and use cases.

Academia has presented many research results related to monitoring and improving air quality and to decarbonisation. Distributed ledger technology (DLT) has gained great attention among the scientific community worldwide because of its promising functionalities. Recently various works have been published, focusing on solutions related to the design of systems deploying the blockchain technology, especially in the air quality, air pollution and environmental data fields.

To achieve the Smart City context to deal with the environmental impacts of urbanisation initiatives, access to air quality data could be the first step in the roadmap. Citizens' participation is important by providing measurements or accepting incorporating measuring devices in their daily lives. In [8], the citizens' involvement in air quality monitoring is proposed by utilising smart metering devices. Thus, high-quality data of interest for many city stakeholders can be obtained and distributed

among them. Smart monitoring kits, combining both hardware and software components, are proposed to be used, considering their calibration thoroughly to avoid misleading results. Citizens are involved in the process by installing home-based environmental sensors. Using Smart Contracts in the BC, the citizens provide data and get rewarded. The aim is to increase the involvement of several stakeholders, such as the community and third companies.

At the same time, with the promising 5G technology, the Internet of Things (IoT) approach can be substantially combined with the DLT. In [9], an IoT BC enabled Air Quality Monitoring System for Smart Cities is proposed. The whole system design is based on an architecture consisting of four entities, i.e., air quality sensors, cloud nodes, BC nodes and the user interface. It is claimed that in opposition to the solutions that adopt centralised solutions and not distributed ones, the combination of the IoT and the BC technology can assure the tamper proofness, safety and the validated data storage, after being received automatically by the sensors, possessed either by individuals living in cities or by the municipalities. Use cases prove that serious data frauds can be prevented by adopting the BC technology, while safe environmental data monitoring processes can be assured, as discussed in [10]. The adoption of BC infrastructures leads to the ability of the interested stakeholders to build customised, reliable, and scalable management solutions according to their specific needs, while through the combination of IoT and BC technologies, measurements extracted from environmental sensors are stored after being checked by the system automatically.

The BC technology proves to be efficient while trying to avoid falsification of environmental pollution data, which comprises a common phenomenon resulting from the utilisation of the traditional data collection method, as discussed in [11]. In this work, the air quality measurements coming from data acquisition devices are gathered to a big data platform, i.e., the original data is recorded directly to the platform avoiding data distortion. Moreover, in the framework of the BC implementation, data processing requires consensus, which further enhances the supervision and the credibility of the data to be uploaded. Even though the storage of the original data in the blockchain acts as a catalyst for the quality of the collection, it may result in GDPR incompliance, connecting the measurements with their real sources. Additionally, storing data in a BC infrastructure comprises an expensive solution. To tackle this issue in [12], a model based on the BC technology is proposed, where air quality data are directly sent from the sensors to the BC infrastructure (Ethereum) after being checked for their validity. At the same time, the InterPlanetary File System (IPFS) protocol is considered for file storage. This system generates a hash for every data stored, based on the content of the corresponding data, which then can be stored in the BC.

Moreover, combining the IPFS protocol with the DLT can enhance the storage of an extended amount of data while keeping a low transaction cost. Based on such an infrastructure, environment-related data obtained from sensors can be automatically sent to a BC infrastructure, choosing the reference day period, i.e., the exact time span of the day for which monitoring is needed, as proposed in [13]. Also, the system can

be customised accordingly to be able to retrieve, format, and organise data according to the set specifications. The measured parameters can be reached through the transaction recovery and management system.

Finally, another challenge to be dealt with in the design of a system to monitor air pollution and environmental data is related to the handling of the input devices, i.e., the sensors, which can be either stable, or portable. Data collected from portable sensors are handled successfully in the pollution monitoring system (PMS) proposed in [14]. The data authenticity, availability, and tamper-proofness is achieved through the adoption of a BC architecture. As portable sensors introduce several challenges, the time resolution and the bandwidth of the received measurements are limited, considering the system specifications. By choosing the distributed perspective in this work, each consortium member participating in the research operates a unique network, i.e., no third parties are involved in any case. The presented PMS is built upon a private-permissioned distributed ledger, providing data transparency within the consortium members which operate it. At the same time, application programming interfaces (APIs) can be introduced to provide data access to people outside of the consortium. Thus, the system's scalability is achieved, which is desired in such applications.

It is concluded that implementing air quality, air pollution and environmental data monitoring systems deploying the BC technology can be highly efficient while dealing with measurements coming from multiple devices in an urban area. The citizens' participation assures access to less bulk and centralised system. At the same time, it allows high granularity to the level of the participating citizens, enhancing the access to data adapted accordingly to their daily habits. At the same time, data processing and storage can be facilitated, as manual procedures are replaced by automated ones, and data falsification can be avoided. The main concept describing the DLT can assure data immutability and tamper proofness.

Additionally, commercial applications deal with the same topics, i.e., air quality and decarbonisation [7], [15]. The challenges are that current air quality monitoring methods are inadequate. They usually do not offer real-time data reporting, and air pollution is monitored through large, expensive scientific instruments installed in a few locations. Thus, delays in alarms for pollution peaks and a lack of warnings to endangered populations can occur. Planetwatch [7] intends to provide a solution to tackle this issue by developing a new global high-density, low-cost sensor network of mobile (small, quiet, unintrusive and wearable) air quality sensors. The sensors will be provided to any interested citizen who commits to use the sensor and send air quality data to the ledger. This action is rewarded with tokens. The devices will validate, filter and display the data in real-time through a mobile app. The data will be published onto the Algorand BC, a green BC, which is energy conscious with the minimal processing power needed to achieve consensus in its innovative pure proof-of-stake approach.

Other initiatives focus on tracking the CO_2 footprint of product production. The Climatetrade's solution [15] provides a marketplace for the compensation of CO_2 emissions, aiming at changing the traditional "buying and selling" model among companies interested in offsetting their emissions without intermediaries and automatically generating a real positive impact on the protection of the environment. The marketplace allows managing the carbon offsetting activities of a company in the most cost-effective way, resulting in carbon neutrality. They have full control over where to invest the environmental capital of their company, as total traceability and trust are offered. When the user initiates the purchase, the exact carbon footprint generated by the product or service is calculated. The footprint cost is sent to the user, enabling him/her to decide with which projects he/she wants to compensate it. Finally, the user automatically receives by e-mail a nominative certificate with all the information about the project. Several companies and institutions in Spain react as case studies.

There are also BC implementations oriented towards monitoring the health and wellbeing in a working environment [16]. HOPU proposes a technological innovation for monitoring the health of a working environment in real-time. The industry can verify real-time control of the area to satisfy the regulations regarding the working environment with certified data and justify critical decisions in the environment. Once installed in the final environment, the device begins to collect data from the work area, detecting any high levels of harmful gases, suspended particles, odours, and noise, which may be harmful to the employees. Any anomaly or alert is stored in this device along with the time and date in a certified manner, ensuring that this data has not been altered. In this way, they can be exported by the risk managers of the enterprise or by any regulatory company associated with the enterprise. In addition, this process checks and certifies that the data conforms to the most demanding regulations. To test the solution, a plastic factory acts as a pilot case. They seek to ensure that the work environment is suitable for pregnant and nursing women and monitor the employees' health. Continuous monitoring of data from the working environment through the Smart Spot HOPU devices is performed. Data is analysed, and anomalies and events are detected. For this development, the Alastria network is used. In this way, compliance with regulations in the workspace is verified. A calculation of total emissions is provided, and all these in an accessible and intuitive interface to access the data both in real-time and as historical.

In terms of **sustainability,** several projects, commercial and non-commercial, are being developed, taking advantage of blockchain technology to promote social participation [6].

Plastic neutrality is the goal to be met through a circular economy [6]. The IBM Plastic Bank concept is based on the idea that everything can be purchased using plastic garbage. Participants collect plastic and exchange it for a reward stored in an online account. The plastic is sold to big brands that have commissioned social plastic in their products. The Plastic Bank leverages BC and IBM Cloud technologies to create

an application that helps incentivise ocean plastic. A security-rich, scalable reward system—a BC banking platform—that runs on the IBM Cloud has been developed. The entire ecosystem is supported through an online banking platform that provides the transfer of value globally. The app adds rewards, incentives, group prizes, user rating and gamifying aspects.

Under the similar scope, the PTwist project has been developed [5]. This research project aims to design, deploy, and validate an open platform that will twist plastic reuse practices by boosting citizens' awareness, circular economy practices, and sustainable innovation in line with the new plastics economy vision. Crowdsourcing tools, tokens and wallets, a rewarding system and a virtual marketplace, are implemented. Cutting edge gamification, analytics, and circular economy mechanisms are used under an open platform. Plastic is considered an asset potential due to increasing its circular economy re-entering. PTwist will impact citizens and grassroots groups' co-creation, innovative and trusted collaboration and knowledge transfer by increasing all stakeholders' awareness. Innovation activities in PTwist will be based upon existing open-source, blockchain, gaming, crowdsourcing components, open data solutions and developments to the largest possible extent. The solution is tested on three pilots.

Other applications of the BC are identified on **energy trading and public governance**. In this view, [17] has developed an ecosystem of applications focusing on the needs of consumers and producers in the energy markets, such as decentralised energy exchange, grid balancing distributed application (dApp), electric vehicle charging dApp and retailer billing dApp. For instance, the decentralised retailer use case builds a virtual machine that acts as an autonomous agent on a BC, which conducts the exchange in a trustless and peer-to-peer manner. The Ethereum protocol has been used. Moreover, in the project "rooftop that feeds" by Communitaria [18], the solar energy produced in deprived neighbourhoods is exploited for food at local shops. Smart Building IoT hubs are used to measure the produced solar energy, and a BC application is used for the transactions. Specifically, the solar energy produced by the habitats of these neighbourhoods is sold to local shops, and local shops pay it with a Community Currency (an ERC-20 sidechain token). Afterwards, neighbours use the Community Currency to buy at local shops. Also, donations and support for vulnerable families are provisioned.

The cutting-edge technology is also used for public governance applications, such as insurance and online voting [2], [19].

PRIViLEDGE [2] is a Horizon 2020 funded project that aims at developing and advancing techniques that enhance privacy, anonymity and efficient decentralised consensus for DLTs. The results are demonstrated through four ledger-based solutions, concrete applications on cryptographic schemes and protocols for privacy and security, on BCs and distributed ledgers: verifiable online voting, contract validation and execution for insurance, university diploma record ledger, update

mechanism for stake-based ledgers. The common challenges are the following: Strong confidentiality, Verifiability, Identity Services, Private Communication Channels. PRIViLEDGE realises cryptographic protocols supporting privacy, anonymity, and efficient decentralised consensus for DLTs.

A self-sovereign identity is a form of decentralised digital wallet running on a smartphone or a personal computer. It proposes that individuals can own digital wallets to manage and present their digital assets (passport, academic degree, property title, money, etc.) and that they can share and exchange them with security guarantees and privacy maximisation. Firstly, this enables individuals to have sovereignty on the administration and presentation of their digital assets and credentials, tokenised. Secondly, it eliminates the need for a third-party entity to act as a verifier since it can be done using BC. A decentralised digital wallet is used in public governance in Turkey [19]. At the same time, Germany and Spain have already signed a declaration for cooperation and exchange of best practices in the field of self-sovereign identity [20].

4. Market, policy and regulatory status and challenges in the design of MSCCP and SCCCP

The current status has been investigated through a combination of desk research and meetings with selected experts, including civil servants of EU institutions and cities, practitioners, and experts of standardisation bodies. Research has been focused on three basic elements that are key-elements in the design of MSCCP and SCCCP: a) Blockchain/DLT, b) Self Sovereign Identity and digital wallets and c) tokenisation and crypto-assets. Four different angles have been specifically looked upon: a) technical, b) law & ethics, c) sustainability, and d) ecosystem. A special focus has been given to cases using blockchain solutions for climate-related challenges and civil engagement.

According to market review, Blockchain is considered a promising technology to develop smart city solutions. Interest in the distributed ledger technology is now growing due to the advances in crypto-assets, smart contracts, digital assets, and other so-called Web 3.0 technologies, together with digital identity and Central Bank Digital Currencies (CBDC) [1]. The use of Blockchain in the cities is still low, compared to the applications in the business environment, but the benefits have been already identified [1], [2]. Cities are open to the adoption of Blockchain-based solutions, developing their own projects and preparing for the wider impact since adoption is considered a given fact [23] – [25]. However, challenges have been identified that are mainly linked to a limited level of capacity building in the cities as well as to legal uncertainty and regulatory barriers.

Meetings were held with European and national civil servants and experts working in European Blockchain and Digital Identity related projects (mainly EBSI and national related initiatives). Further, meetings were organised with leaders of relevant smart

city and climate-related projects, which use blockchain technologies within the EU, as well as INATBA and EU Blockchain Observatory and Forum. The third set of meetings included relevant practitioners involved in the development of Digital Identity market solutions. Finally, meetings have been organised with officials and market experts involved in standardisation bodies (UNE, CEN-CENELEC and ETSI). Emphasis was given to implementations where specific issues have arisen within the EU jurisdiction.

Conscious of the value that the EU institutions see in the proper use of Blockchain technology for citizens´ related services, several experts referred to the alignment of DivAirCity with the EU Blockchain Strategy and in particular with its "gold standards" for blockchain technology in Europe [26]:

- **Environmental sustainability**: Blockchain technology should be sustainable and energy-efficient.

- **Data protection**: Blockchain technology should be compatible with, and where possible, support Europe's strong data protection and privacy regulations.

- **Digital Identity**: Blockchain technology should respect and enhance Europe's evolving digital Identity framework. This includes being compatible with e-signature regulations, such as eIDAS, and supporting a sensible, pragmatic decentralised and self-sovereign identity framework.

- **Cybersecurity**: Blockchain technology should provide high levels of cybersecurity.

- **Interoperability**: Blockchains should be interoperable between themselves and with legacy systems in the outside world.

The Member States of all the Cities involved in the DivAirCity project have signed the European Blockchain Partnership [27], created in 2018 and aiming to cooperate in the establishment of a EBSI that will support the delivery of cross-border digital public services, with the highest standards of security and privacy [28]. In principle, DivAirCity is not focused on cross-border activity but cross border interactions and use of data should be made possible. In this sense, EBSI developments need to be followed as they are aligned with the key DivAirCity project objectives. EBSI is declared to "*simplify the verification processes by changing the way citizens, businesses and public administrations share information and trust each other*" [28].

Since 2020, EBSI is deploying a network of distributed nodes across Europe, supporting applications for selected use-cases. Experts have indicated DivAirCity, or

each of the Cities might wish to consider applying to be an EBSI use case in the future since EBSI offers benefits to the key DivAirCity stakeholders (public administrations, citizens and businesses). Specifically, it is built to allow citizens to take control of their data, secure them and easily move with their own credentials across Europe. It also protects public administration against fraud, increase trust and security and make the verification of data authenticity easy and cost-efficient [28].

In the meetings, particular attention was given to the work on Self Sovereign Identity as a use case within the EBSI framework and as an essential element of data services with privacy. Independently of whether EBSI infrastructure is selected for the deployment of the DivAirCity dApps, Digital Identity Wallets used within DivAirCity should be compliant with EBSI´s Wallet Conformance Testing and follow the related technical standards [29]. In this sense, it is of key importance for DivAirCity to follow the developments of the European Commission´s proposal to amend the eIDAS Regulation (commonly referred to as eIDAS) introduced in June 2021 [30]. Specific focus should be given to the proposed European Digital Identity Wallet, which will be available to all EU citizens, residents, and businesses in the EU and usable not only for identity documents but also for all attestations, including those with sensitive personal data, such as health data-related documents [31]. The concept implies working with digital IDs to hand control of data back to the individuals by allowing them to hold their identity on their device and choose with whom they wish to share the data. DivAirCity faces the challenge of designing a ready to market product in a fast-evolving market and regulatory context. Therefore, it is necessary to monitor and follow the current EU evolutions in this context. On the 23rd of February 2022, the European digital identity architecture and reference framework has been released and also considered in this document [32].

The same applies to the rewarding scheme through tokenisation. The Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on Markets in Crypto-assets, and amending Directive (EU) 2019/1937 (MiCAR) [33] is expected to be approved soon and it will need to be applied to the DivAirCity solutions where applicable. The nature of the reward system is designed to exclude monetary payments. However, it is deemed relevant to follow the European Central Bank's announced plans to move forward with a 2-year project exploring the issuance of a digital euro (Central Bank Digital Currency) announced in July 2021 [34].

Experts stressed the importance of the increased levels of legal certainty and the impact in DivAirCity of the current blockchain-related legislation and the legislation in progress within the EU. National legislation and the guidelines issued by European Agencies need to be followed. Reference has been made to EBA Report with advice to the European Commission on Crypto-assets (9 January 2019) and the ESMA Advice to the EU Institutions – Commission, Council and Parliament – on initial coin offerings and crypto-assets (9 January 2019) [35], [36].

Although it is not yet clear whether any of the activities linked to DivAirCity will fall under the scope of the 5th Anti Money Laundering Directive [37], it will be ensured that crypto-assets created or used in the context of the project foresee compliance with the national legislation transposing this directive, which is already undergoing revision.

As to the need to provide legal certainty to the users of the dApp, the value of public permissioned blockchains was raised as it is easier to define applicable jurisdiction to the blockchain network itself. Alastria Blockchain ecosystem was presented as such public permissioned blockchain. In use since 2017, it has been developed to be compliant with EU legislation providing functionalities similar to other widely used BCs with low energy expenditure and providing own digital identity solution, which has been used to develop the UNE standard. Alastria is compatible with Ethereum and its use does not require expenditure in gas cost which represents and advantage for budget control.

Specific elements within the blockchain technology and applications were identified as particularly worth focusing on for the DivAirCity project. First is the concept of decentralisation and its role for diversity-based collaboration. Second, consensus mechanisms as a key source of trust. Consensus has also been specifically studied from the sustainability perspective since it generally defines the energy consumption levels of the blockchain/DLT infrastructure. Literature related to these issues has been carefully and critically revised. Particular attention has been paid to the reports issued by the EU Blockchain Observatory and Forum, specifically those focusing on energy [38], governance [39], cybersecurity [40], data protection [41], tokenisation and health-related use cases [42]. EU blockchain trend reports have been also considered (especially those including the latest developments and published in May 2021, July 2021, November 2021).

Finally, developments of standardisation to blockchain-related issues and Digital Identity need to be closely followed and considered in the design of MSCCP and SCCCP. Efforts in this field are significant and in progress in several national, European and international standardisation bodies [43].

Regarding Digital Identity, the Spanish Standardisation Body UNE approved the first worldwide standard (CTN 71/SC307/GT). CEN-CLC has a Joint Technical Committee devoted to DLT and Blockchain, the European equivalent to ISO TC 307. Recently working group 1 (CEN/CLC/JTC 19/WG 01) was created, which will be devoted to decentralised digital identity and is working on drafting a technical specification on blockchain-based decentralised ID. Within ETSI there are currently three workstreams: a) DTS/ESI -0019462 (electronic signatures and infrastructures (ESI); Wallet interfaces for trust services and signing; b) DTS/ESI-0019471 (electronic Signatures and infrastructures (ESI), policy and security requirements for attribute attestations services and c) DTS/ESI-0019472 (electronic Signatures and infrastructures (ESI), profiles for attribute attestations.

5. Cities' current status

A first step towards defining the requirements for MSCCP and SCCCP is to start with understanding the relevant developments that are already present in the cities involved in the DivAirCity project. To obtain this information, a specific questionnaire was developed and sent to the cities. The questionnaire particularly aimed at identifying whether the Cities:

a) Have already used blockchain technology for any of their activities, and in that case, what was the nature of the blockchain used.
b) Have included personal data in any of the applications using blockchain technology which are related to the European Blockchain Service Infrastructure (EBSI) in whatever form.
c) Are using Digital Identity wallets.
d) Have developed any type of citizens rewarding systems.
e) Are controlling the use of green means of transport by citizens.
f) Are using diversity criteria in the implemented systems.

The Castellón City Council has adhered to an incentivised recycling system, promoted by Ecoembes (a non-profit organisation that coordinates the recycling of light domestic packaging in Spain) which uses Blockchain. Citizens can receive social and environmental rewards every time they recycle cans and bottles [44]. The application is owned by ECOEMBES, and the city of Castellón has not been involved in its development.

On digital identification, the application of a service called citizen card is being tendered in Castellón. The aim is to provide citizens with unified access to municipal services such as the bicycle loan service, library, bus vouchers, and the management of free parking vouchers by local business establishments, etc. In this application, the card may be used as an identification mean to use the public services. The technology for implementing the ID card does not include Blockchain technology.

As to the ethical codes, the municipality of Castellón has signed a code of good governance in which public, professional, ethical, and democratic values, based on the daily commitment to serve public interests, are defined [45].

The other cities have not reported any use of blockchain technology, or any direct relation to EBSI. Therefore, also there is no blockchain-based application that has so far dealt with personal data. The cities have not reported using digital identity wallets, nor have they been informed of the existence of citizens´ rewarding mechanisms. Further, the cities have not reported any specific control of the use of green means of transport by citizens.

6. MSCCP and SCCCP structure definition

General approach

The use of technology as an accelerator of social change is the very essence of the DivAirCity project. In this sense, it is and needs to remain clear throughout the evolution of the work carried out by the Consortium that technology remains a tool and never a finality. Every step in building a technical solution will be checked against human and societal effects. Citizens' freedom, social equality and environmental sustainability will be the essential values guiding the decision-making process related to the tasks.

Resulting from the research analysis and previous experience, the goals set in the development of the DivAirCity BC application present different dimensions and constant evolution, which makes the definition of high-level requirements complex.

In terms of stakeholders engaged in the DivAirCity application, there is a high level of diversity regarding their nature, roles, and impact. The presence of public administrations such as the municipalities defines the legal and ethical framework and the business model behind the solution. For instance, applying administrative law will introduce limitations to the potential models. From the financial point of view, the deployment of the solutions shall not impose budgetary obligations to the cities and should guarantee sustainability.

Another level of complexity is brought by the fact that the solution is deemed to serve the citizens and interact with their data. This brings along a set of complex issues linked to the need to protect their privacy and engage them in decision-making processes.

At the citizens' level, the DivAirCity application needs to be built under the lens of diversity, ensuring inclusion and equality. It should also consider carefully the capacities, special needs and the specific skills of the potential diversity group users, so as to provide a functional solution that will be easy to use and understand its functionalities. This is of outmost importance for the acceptance of any solution and therefore for its applicability and sustainability.

Transparency and building trust at the citizens' level and regarding public services linked to them is one of the key elements of the Application.

Eventually, the EU institutions might also need to interact with the solutions, and there might be space for a public-private partnership model as part of the DivAirCity solution.

Taking all the above into consideration, blockchain has been identified as an adequate technology for the purpose of the project. Its decentralised nature brings trust into the system and allows different stakeholders to be owners of the system, which provides comfort to the users. Common access to shared information in a decentralised platform reduces the risks of conflicts among the parties involved in a multilateral task. Further, blockchain helps to automatise processes through smart contracts, bringing efficiency to the relational models. Finally, the possibility to create and transfer rewards through digital means (via tokens and crypto-assets) without intermediaries allows the creation of new rewarding models in trusted environments.

Two major challenges have been identified upfront in the use of blockchain for the purpose of the DivAirCity project.

One is the use of private data and the related legal and ethical risks. In this sense, the Application will be defined under the principle of privacy by design to avoid storing private data in the blockchain. In this sense, the possibility to use identity systems that help maintain high privacy levels and keep the citizens in control of their data will be specifically considered.

The other challenge refers to the need to ensure that the model itself guarantees high sustainability, knowing that several specific blockchain platforms have proved to consume high energy levels and have a high carbon footprint, something incompatible with this project's scope. The definition of the model, as well as the requirements, will pay particular attention to both elements.

DivAirCity MSCCP and SCCCP

In view of the above, the DivAirCity citizens´ participatory model is defined to be a decentralised application running on a blockchain platform.

By nature, blockchain is a technology built on decentralisation, and central governance is excluded. At the same time, encryption is embedded in its nature and ensured by the verification procedure and the distribution.

The different assets of the SCCCPs and MSCCP are built around the blockchain, specifically the smart contracts, the rewarding model and the tokenisation, the digital identity and the wallet. **Figure 2** depicts the key characteristics and functionalities built on a blockchain.

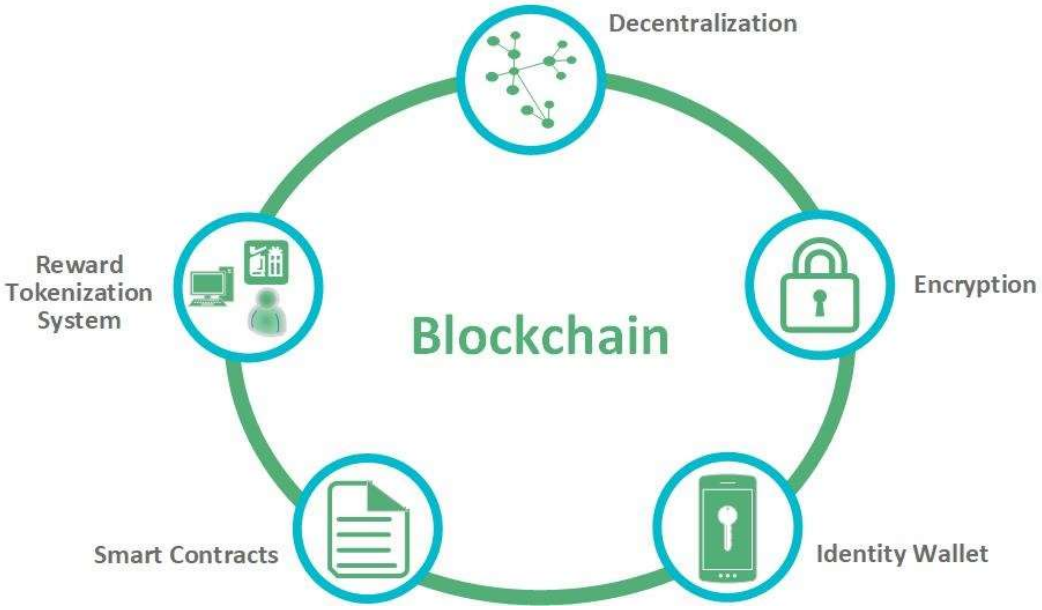

***Figure 2**. Key characteristics and functionalities built on a blockchain*

The Blockchain layer is the heart of the development, being the canvas for developing the smart contracts in which the rewarding model and the marketplace resulting from the co-creation will be translated. It will also interact with the digital identities and the users' digital wallets. The choice for the most suitable Blockchain platform will be taken afterwards, in the phase of the definition of the specifications and together with the data management and co-creation. The last activity will define the layout of the smart contracts and the dApps. dApp, namely distributed application, is an application that runs on a blockchain and manages the data and the smart contracts. All these, together with the rewarding model, constitute the SCCCP.

The DivAirCity MSCCP is the ecosystem that includes the SCCCPs and the interaction with the outer world, e.g., people, sensors, etc., using the proper interfaces. In MSCCP, the marketplace is reflected. Appropriate user interfaces and sensors will be considered, but generally, they will be similar for all the SCCCPs – Cities.

The current document defines the requirements for the key elements of this system, namely the SCCCPs and the MSCCP.

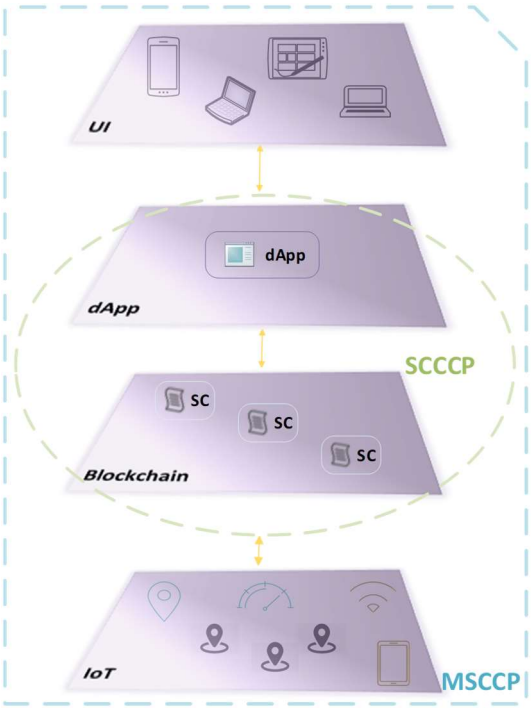

***Figure 3**. DivAirCity MSCCP and SCCCP Architecture*

The design of the MSCCP and SCCCP will require the use of the following tools:

1. Blockchain platform (decentralised infrastructure on which the application will run)
    a) Governance
    b) Technical
2. DivAirCity SCCCPs, including rewarding models through tokenisation and smart contracts.
    a) Smart contracts
    b) Tokens/Crypto-assets
    c) Self-Sovereign Identity model and wallet (privacy-related)
    d) Distributed Applications for high-level interaction with the above elements
3. Interface with the world, including the data acquisition system (IoT) and good UIs for different Users.

7. User Scenarios

Focusing on the cities' DNAs, on the discussion with cities performed during the kick-off meeting and other several meetings and on other existing applications identified during the desk research and presented in Section 3, indicative scenarios have been proposed. These scenarios give an overview of the users' actions by using the

DivAirCity system. They are based on the current situation of the requirements definition process and initial ideas resulting from it. They will be refined in the next months of the project following the results of the co-creation process with the cities.

User Scenario #1. Earning tokens

The user has air quality sensors at home, car, bicycle, backpack. The provision of data is rewarded with tokens. Behaviour change is also rewarded with tokens. For instance, the user may change their way of going to work/school/hobbies from car to bike.

Example 1: Citizen A shares her data from her private air quality measurement station with Bucharest. The city of Bucharest rewards Citizen A with ten tokens.

How it works:

- If the sensor is portable
- Then follow some routes
- And record measurements
- Then transfer them using a digital wallet
- Then get a reward (tokens)

Example 2: Citizen B in the city of Orvieto lives 10 km away from work. Every day, during peak hours, she drives to and from work. To save time and reduce her CO_2 emissions, she switches from using the car to using the bike. She shares her transportation data with the DivAirCity MSCCP. In return, the Citizen is rewarded with tokens according to the CO_2 avoided.

How it works:

- The user inserts the locations of the house and the work and chooses the mean of transportation.
- The application calculates the CO_2 avoided and rewards the user with tokens.
- The user tokens are saved in her digital wallet.

User Scenario #2. Spending tokens

Tokens will be 'stored' in the users' individual digital wallets. They can be exchanged with 'social benefits', like using public bikes, free tickets to events (perhaps offered by sponsors) etc.

Example: Citizens A and B want to use their Tokens to receive free entry into the public swimming pool during the summer and attend an exhibition, respectively. Each activity needs ten tokens.

How it works:

- Given that both users have enough balance of tokens (>10) stored in their digital wallets.

- They submit their request to use them to attend the activity.
- Then each receives a confirmation and a ticket.
- And their token balance is reduced by ten tokens.
- And their digital wallets are updated.

User Scenario #3. Exchanging tokens

The users can exchange tokens that have been earned during actions as described in Scenario 1. Each user's tokens are stored in their digital wallet. Citizens can exchange tokens.

Example: Citizen A wants to spend 60 tokens for two tickets to attend a concert with a friend but has less. They must ask another Citizen to lend them the missing tokens.

How it works:

- To get a free concert ticket, the user needs 30 tokens.
- The user is going with a friend. Therefore, he needs 60 tokens.
- Unfortunately, he only has 52 tokens.
- So, he asks for eight tokens, and Citizen B lends Citizen A 8 tokens.
- Since Citizen A owes to Citizen B eight tokens, as soon as he gets his next reward, he pays back his tokens debt

User Scenario #4. Tracking activity

The users will track their past activity, visualise it and download it locally.

Example: Citizen A has been using the DivAirCity mobile application for six months and has a portable sensor for measuring air quality. Citizen has been actively using the application in everyday life, earning tokens by providing data and behaviour changing and spending them in offered activities. Now, the Citizen wants to obtain an overview of the individual activity.

How it works:

- Given that the user has earned and spent tokens
  - When they ask for their past activity
  - Then several graphs appear, providing details of the transactions, CO_2 emissions reduction and energy savings.
  - Then, the option to download them appears.

8. DivAirCity MSCCP Requirements

The approach followed for defining the requirements and the requirements themselves is presented in this Section.

Methodological approach

Following the purpose and guiding principles that inspire the project, a set of requirements have been developed in view of ensuring that the MSCCP and SCCCPs developed will comply with the identified essential features.

The requirements are structured in two layers:

Layer 1: Essential requirements that need to be fulfilled to consider the solution as a valid option. Therefore, they could be considered more as prerequisites rather than pure requirements.

Layer 2: High-level requirements that are the final requirements on which the DivAirCity system will be designed and constitute the final goal. They are structured in 5 key categories:

a) technical specifications and cybersecurity;
b) regulatory compliance and ethics;
c) user experience / user interface;
d) sustainable economic model and
e) ecosystem definition.

Layer 1: Essential Requirements

Given the complexity of the elements that need to be considered to create a sustainable solution and the high number of possible options in practice, we have established a checklist of preconditions for each of the building blocks:

a) Blockchain/DLT platforms
b) Self-sovereign identity systems
c) Tokenization reward systems.

This allows us to reduce the sample of existing options on which the Layer 2 “High-level requirements” are defined. From a different perspective, the essential requirements allow the exclusion of certain Blockchain Platforms or Applications

based on a preliminary check to enhance the development process. The first layer screening is binary, in the sense that all essential requirements are fulfilled or not (yes/no)/ (comply/not comply). Only those options that fulfil all essential requirements will be considered in the second layer of requirements. These requirements are described below.

ESSENTIAL REQUIREMENT 1: Decentralised solution

Decentralisation provides important values to the system, mainly: cybersecurity, direct access to data, trust and automation, multiparty approach, lack or reduction of intermediaries, increased participation, and engagement.

The delivered solution needs to use based on a decentralised platform. Often the concept of decentralisation is used as a synonym to distribution, but they represent different concepts.

ER1: The Blockchain Platform needs to be distributed and decentralised.

We are conscious that it is important to define the level of decentralisation that is reflected in the governance structure. This layer one requirement is not exhaustive of the analysis of such governance structures, which must take place on a granular approach in a second step. However, if there are signs of centralisation in the first analysis, blockchain infrastructure should be excluded.

ESSENTIAL REQUIREMENT 2: Full privacy for citizens related information

The DivAirCity SCCCPs and MSCCP should be defined to handle highly sensitive and personal information of the participating citizens. In particular, it may include data referring to Citizen's locations and routes, Citizen's use of green means of transport, Citizen's information of AQ sensors, steady or mobile in their possession, Citizens visions, ideas, suggestions to create a novel participatory communication approach.

This information is directly related to citizens´ behaviour, habits, and movements. It also might be easily related to their relationships with other individuals or third parties. This information is directly related to people´s freedom, and therefore, it is essential that the MSCCP/SCCCP guarantees the anonymity of all personal information used.

ER2: Full privacy of all citizens' related information must be guaranteed

ESSENTIAL REQUIREMENT 3: Full compliant system with all applicable legislations

It goes without saying that any model developed to be effectively used in the EU context needs to be fully compliant with applicable legislation. MSCCP and SCCCPs need to comply with the EU, national and regional legislation. It needs to comply with all sector legislation, i.e., civil and commercial law, administrative law and tax and financial law. An applicable jurisdiction both for the blockchain platform and the SCCCPs and the Tokenization model should be defined. In this regard, based on the current regulatory and market research, we specifically point out the relevance of privacy legislation, Anti Money Laundering (AML), consumer rights and investors' rights. Legislation is dynamic (i.e., changes over time); therefore, the final Application needs to provide a compliance control structure to ensure its compliance with applicable legislation and adaptation to any legislative changes. The Cities will provide the legal check process and accountability structure.

The use of Blockchains operating under a clear jurisdiction would reduce the regulatory risks.

ER3: Full compliance with existing EU, national and local legislation

ESSENTIAL REQUIREMENT 4: Compliance with Ethical Charter of DivAirCity

Since the Application will deal with socially sensitive citizens' groups, it is essential to comply fully with the DivAirCity Ethical Charter and any other ethical policies, codes, regulations, and guidelines the participating cities have adhered to. The Cities will define the structure responsible for controlling compliance with ethical charts.

ER4: Full compliance with the DivAirCity Ethical Charter

Table 1 proposes a requirement revision chart for the SCCCPs and the MSCCP for compliance with the Essential Requirements. A "No" in the table excludes the solution, and there is no need to proceed with further analysis of compliance with the High-level requirements (Layer two).

Table 1. Essential Requirements Revision Chart

	Essential Requirement 1 Decentralised	Essential Requirement 2 Privacy legislation compliant	Essential Requirement 3 Compliance with EU, national and local regulations	Essential Requirement 4 DivAircity Ethical Code compliant
Blockchain or DLT	YES/NO	YES/NO	YES/NO	YES/NO
Self-Sovereign Identity Wallet	YES/NO	YES/NO	YES/NO	YES/NO
Tokenisation Rewarding Model	YES/NO	YES/NO	YES/NO	YES/NO

Layer 2: General requirements

In Layer 2, the set of high-level requirements that the MSCCP and SCCCPs need to comply with have been defined. The methodology applied for the definition of these requirements has been based on a matrix approach. The building blocks of the MSCCP and SCCCP have been reviewed for several functionalities. The functionalities examined are the following:

a) technical background and cybersecurity;
b) regulatory compliance and ethics;
c) user experience / user-friendliness
d) sustainable economic model and
e) ecosystem definition

To each Requirement, a prioritisation has been given by a suitable verb. Thus, “must” is used for a high priority requirement, “should” stands for a medium priority, and “may” appears in low priority.

The DivAirCity MSCCP high-level requirements are the following:

***Table 2.** High-level requirements*

R1	The Developer must be able to log in to the platform.
R2	The Developer must be able to create a Smart Contract.
R3	The Developer must be able to deploy a Smart Contract.
R4	The Issuer must be able to grant permissions to one or more users to enter the MSCCP.
R5	The Blockchain Platform must support Smart Contracts.
R6	The Blockchain Platform must support dApps.
R7	The Blockchain Platform must support tokenisation.
R8	The Blockchain Platform must support DIDs and Digital Wallets.

R9	CEN/CLC/TC 13 *Cybersecurity and data protection* standard must be considered while developing the MSCCP/SCCCP.
R10	The data format obtained from heterogeneous sources, i.e., external devices, should be checked and adapted (if necessary) to comply with the MSCCP/SCCCP input profiles.
R11	The data provided by sensors and the IoT must be checked syntactically and semantically before being stored and used.
R12	The SCCCP must be compatible with the software of the devices of the IoT (such as sensors).
R13	The MSCCP/SCCCP must be scalable, allowing extensions and generalisations without a need for extreme adaptation.
R14	The Blockchain platform consensus costs must be low to make the MSCCP viable.
R15	The Blockchain Platform must consume the lowest energy possible, i.e., green blockchain.
R16	The Users must be protected from profiling/tracking to avoid retrieving background information from external parties.
R17	Confidentiality must be considered to protect personal and nonpersonal information from unauthorised external usage.
R18	The MSCCP must be compliant with all legislation applicable in the involved jurisdiction. The cities must provide legal and technical structures that assume responsibility for ensuring compliance with the MSCCP.
R19	Ethical principles, as defined in DivAirCity Ethical Charter, relevant EU legislation, national and international law, including the Charter and the European Convention for the Protection of Human Rights and Fundamental Freedoms and its Supplementary Protocols, must be respected.
R20	The MSCCP/SCCCP should respect the principle of proportionality, the right to the physical and mental integrity of a person, the right to non-discrimination and the need to protect the environment and human health protection.
R21	The MSCCP must comply with the Ethical Framework and ethical Chart designed in the framework of the DivAirCity project.
R22	The MSCCP and every action related to it and its impact should comply with the equality principle of the UN Human Rights Convention on the grounds of sex, racial or ethnic origin, age, disability, sexual orientation, religion, or belief.
R23	The MSCCP/SCCCP should ensure equitable and universal access to opportunities and treatments.
R24	MSCCP governance must be transparent for all involved users.
R25	The MSCCP must provide users with a user-friendly interface.
R26	Users' private data must be protected from unintended public exposure and exploitation.
R27	Data collection must be handled with privacy, e.g., sensitive data anonymisation, when necessary, separate data on or off-chain to avoid using sensitive personal data in the chain when required, etc. Privacy in data separation must be considered by design.

R28	Data must be stored with privacy implementing encryption and de-associating data from physical identities.
R29	Data must be shared and processed with privacy, e.g., deploying data privacy policies, etc.
R30	No back traceability of any data or correlation of data to its source should be allowed.
R31	Both the proposed eIDAS 2 Regulation and the proposed EU identity wallet should be considered.
R32	For the Issuer to provide credentials, the identity must be proofed, while the identity information must be verified.
R33	The credential management process must be clearly identified.
R34	The users' level of anonymisation should always be transparent to all engaged stakeholders.
R35	The self-sovereign identity approach should be considered for the Users to maintain control of their digital identities.
R36	Verifiable credentials should be created for data transfer in an understandable and usable way.
R37	The SSI should be considered as a fully portable digital identity for providing access to all the MSCCP services.
R38	The DID must provide a single user account.
R39	The DID must provide a safe user account.
R40	The Digital Wallet must allow users to interact with the MSCCP, perform transactions, and participate in the rewarding system.
R41	The Digital Wallet must store users' balance, transactions and other necessary data for the transactions and implement the Smart Contracts.
R42	The Digital Wallet must be created upon account creation.
R43	The system must be provided free of charge, with users able to create free accounts.
R44	The Application and the included information must be accessible and usable by the users.
R45	The Application should be simple and easy to be used by different user categories by customising the interface according to their needs.
R46	The Application may be personalised according to the needs and preferences of the users.
R47	The Application should allow the users to perform changes, e.g., turn on/off data acquisition, give/deny their consent, when appropriate.
R48	All users, especially those with low digital literacy, should use the Application and access any available content.
R49	Appropriate instructions should be incorporated for guidance in using the Application.
R50	The Application and the incorporated instructions should be translated into the local language of the users in the pilot sites.

R51	The Application should provide visualisation of the individual, own activities, and transactions of the users.
R52	The users should be able to see their past activity and track their current activity.
R53	The Application should be compatible with multiple operating systems.
R54	Registration and any other input required by the system to be inserted manually by the user should be implemented via the Application. The user interface should be the only way of interaction between the Users and the application's backend.
R55	The users must be able to log in to the Application whenever they need, using their DID.
R56	The Blockchain Platform must support tokens to enable users' rewarding for their achievements and the provision of data by introducing an awarding system.
R57	The users must be able to exchange tokens of the same kind with other members of the MSSCP keeping track of the transactions, but trading is not allowed.
R58	The tokens must be able to be stored in the individuals' Digital Wallet.
R59	The Application must provide the capability to exchange tokens for benefits.
R60	The Application may allow the users to set interest locations, e.g., home, work, etc.
R61	The Application may offer recommendations for routes with less CO_2 production and better air quality harmonised with projects goals.
R62	The users should be able to save recommendations for later.
R63	Users may be able to set notifications for air pollution increases.
R64	The MSCCP may be able to use the location data of the users in the framework of the rewarding scheme only with a full privacy guarantee. For this, SSI mechanisms will be explored.
R65	The MSCCP should keep aggregated records of the routes, CO_2 and air quality based on users' actions and visualise them, without any correlation or traceback to the source.
R66	Diversity must be considered in defining the rewarding mechanisms at the cities level.
R67	The MSCCP must provide interactive dashboards for visualisation customisable to the diverse user categories without any correlation or traceback to the source.

9. Conclusion

This document provides a twin set of requirements for the SCCCPs and the MSCCP of the DivAirCity project. The requirements are divided into essential, which practically identify if a solution is to be further evaluated, and high level, which deals with the structure and the overall functionalities of the Application to be developed.

Following an extensive overview of Blockchain-based applications, those related to the scope of the DivAirCity project have been identified and analysed. Many meetings and discussions with the DivAirCity cities have been done, eventually leading to a better understanding of the functional details of the DivAirCity SCCCPs and MSCCP. Furthermore, meetings with market stakeholders who have launched Blockchain-based applications were organised to investigate issues during the development and implementation. Further meetings had a place with European Commission and public administration officials involved in Blockchain applications. Finally, research on any potentially similar implementation in the cities showed no results.

Indicative scenarios have been developed to highlight the potential use of the Application. This effort is subject to further evolution in several of their aspects. The DivAirCity project will prepare a set of updated requirements and specifications directly related to the project's activities, mainly the co-creation activitiy of the DivAirCity project, which is expected to fine-tune some of these requirements.

The work done in this document is practically a first step in designing the DivAirCity SCCCPs and MSCCP. It continues with the next document, entitled '*Specifications of MSCCP and SCCCPs – Version 1'* , with the corresponding technical specifications, in close relation with the outcomes of the other DivAirCity project activities, namely the *'Digital Innovation and D&I Data Management Framework'* and the *'Participatory engagement and people driven framework'*.

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Annex: Questionnaire

Block 1: Use of Blockchain technology and privacy related elements

Does your city use any blockchain platform? If yes, what is the use case?

Is there personal data stored in the blockchain?

Is it a public, public permissioned or a private blockchain?

Does your city participate in EBSI with and EBSI node?

If yes, what is the use case?

Block 2: Use of digital identity and SSI

Does your city/country use any digital identity wallet?

If yes, does your digital identity wallet have DIDs, credentials?

Block 3: Use of citizens ´reward systems

Does your city use any citizens reward system?

Are citizens using any type of digital wallet to store the information?

Block 4: Control of the use of green means of transport by citizen

How is the use of green means of transport controlled in your city?

Are there stimuli to the use of green means of transport?

Block 5: Diversity in technical systems

Are there diversity checks in the systems implemented?

Block 6: Ethical codes

Has the city developed or adhered to specific ethical codes or similar documents?