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Building Urban Resilience of Public Places in Volos, Greece. Perspectives and possibilities of related contribution of Blockchain technology.

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Abstract: This chapter explores the contribution of public places for building urban resilience in Volos (Greece) and investigates the potential of Blockchain technology to overcome challenges of urban resilience. It is argued that public places can be considered as useful tools for risk mitigation, emergency response, recovery and adaptation if they have social, economic and environmental capacities. A case study investigates risk mitigation and emergency response practices in urban environment in Volos, identifies physical and social resilience credentials of its public places, and analyses the existing institutional framework for disaster prevention. Consequently, it proposes strategies to increase the adaptive capacity of public spaces and argues that digital inclusion can reinforce their resilience and improve the existing risk mitigation and emergency plans. In this framework this paper reviews the unique features of Blockchain technology, the essential conditions which determine their use and explores detailed cases where Blockchain was used. It argues that Blockchain has a potential to strengthen resilience of public places in Volos by improving their social, institutional, environmental and economical capacities.

Keywords: urban resilience; public places in Volos; Blockchain technology.

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1. Introduction

Modern cities face challenges of urban vulnerability, adaptation and resilience in the context of climate change and social crisis. Critical city systems must remain functional and accessible in the face of external stresses and shocks. Discussions around urban resilience have promoted research on how cities can benefit from use of new and promising Blockchain technology before, during and after crises. The application of Blockchain technology for supporting urban resilience is at an early stage and so this paper considers how this technology can be a component of smart city strategies.

The proposed paper provides reviews of different approaches to urban resilience, where urban resilience is described as a sustainable process, providing capacities for positive change and ability to move forward and improve in response to stresses. It argues whether public places can be considered as useful tools for risk mitigation, emergency response, recovery and adaptation if they have social, economic and environmental capacities. It examines whether strengthening social capacity of public spaces and building place capital through inclusive practices contribute to their resilience to face natural disasters and social crises.

The case study investigates risk mitigation and emergency response practices in the urban environment in Volos, Greece, it identifies physical and social resilience credentials of its public places and analyses the related institutional framework for disaster prevention. It takes into account that, during an emergency, public spaces are mainly used for providing shelter, gathering of people and distribution of services, goods and information. In cases of social crises public spaces shape the relationship between local community and affected social groups. The capacity of the public places in Volos, to adapt to different anticipated and unexpected risks, is also assessed, and related strategies for improvement are proposed.

Finally, emphasis is given to the potential of Blockchain technologies to further improve the contribution of public places for building urban resilience generally and in Volos.

2. State of the Art

2.1. Defining resilience

Different approaches to resilience have been widely discussed in academic and policy literature in recent years. They are characterized by short term (reactive) engineering resilience and long term (preventive) ecological resilience (Folke and Gunderson 2010).

Engineering resilience is a “bounce-back” system, which is aiming to return to its pre-disaster state as quickly as possible and operating within one regime (Manyena et al.2008; Vale 2014). This approach leads to increased vulnerability in the long-term and failure to deal with urban sustainable targets (Sanchez at al. 2017).

Ecological resilience is a “lasting form of resilience” having an ability to adapt to adverse events and change (Angeon and Bates 2014; Redman, 2014). It based on three aspects: being able to absorb disturbances while remaining within an acceptable state and having a capacity to self-organize, to learn and adapt (Davoudi et al. 2013, Folke et al.2002).

In this chapter the definition of urban resilience by Meerow at al. (2016) is adopted, where urban resilience refers to “the ability of an urban system and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales, to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity" . In this definition urban resilience is described as a sustainable process, having capacities for positive change and thus, an ability to move forward and improve in response to stresses.

Urban resilience comprises phases, which include preparation, emergency response, recovery, reconstruction and adaptation. Preparation includes risk mitigation, emergency and disaster planning, and recovery planning. Short-term recovery focuses on the immediate tasks (e.g. securing the impact area, housing victims, ets.). Long-term reconstruction deals with psychological, demographic, economic, and political impacts of disaster. Community resilience is fundamental to mitigating loss and damage from disasters. A resilient community increases "the resilience dividend" and contributes to creation of "place capital" (Jacobs 2015).

It is noted that the "adaptive capacity of urban system should be built though priority sectors", prioritizing risks and long and/or short-term resilience targets (100 Resilient Cities 2017). For example, the resilient plan of Athens proposes sustainable strategy for adaptation and future development including open city governance, green city, proactive (survival skills through communication and planning) and vibrant (promoting well-being, creativity, entrepreneurship) city and a new, inclusive, and exciting identity. World Bank in 2012 proposed a strategy which includes a hazard impact assessment, institutional assessment, and a socioeconomic assessment (Dickson at al. 2012). UK government proposes to conduct National Risk Assessment by sector, which includes energy, food, transport, water, government, etc.) and to have strategies to mitigate the relevant to the specific sector risks (Cabinet Office 2016).

2.2. Contribution of public places to urban resilience

ARUP (2016) proposed to use an index to assess the resilience of cities. The index is based on the capacity of the city to enable its users to meet their basic needs in city organization (economy & society), people (health & wellbeing), places (infrastructure & environment), knowledge (leadership & strategy). These dimensions are underpinned by 12 goals and 54 indicators, which addresses 7 qualities of resilient systems, including reflectiveness, integration, robustness, resourcefulness and flexibility is developed for each sector (ARUP 2016). These qualities provide urban spaces with adaptation capacities to deal with multiple threats because they offer social (community resilience), economic (e.g. encouraging local economy), environmental (e.g. reduce urban heat effect, provide water storage and carbon absorption) and provide personal health benefits (CABE 2017; Kabisch at al. 2017).

To function well during both emergency and non-emergency times, public open spaces should be part of everyday city life, where elements of flexible design provide public spaces with a variety of urban functions (Perkins 2008).

Public open spaces contribute to all levels of urban resilience by strengthening social capacity of the urban environment and building place capital through inclusive practices and collective creativity (Jacobs 2015). Significant elements of these practices are considered. They includes collaboration of uses, empowerment of community, co-creation, interactivity, connectivity, equality, accessibility, efficiency, convenience and flexibility (CABE 2006). Collective creativity provides people an equal opportunity to engage in the decision making, where everyone can be creative and contribute to the place making. Integration of resources during place making improves the adaptability and flexibility of the community. Inclusive strategies for engaging hard-to-reach stakeholders establish new partnerships for carrying out collaborative work.

Public places can be considered as useful tools for social adaptation before, during, and after crises. The recent refugee crisis has revealed that hosting large numbers of population in move has a serious impact in European societies and cities. The impact of the new arrivals largely reflects economic and social issues that host communities were facing before refugee crisis (World Bank 2017). Public spaces can reshape the relationship between local community and refugees through co-creation, planning, and cooperation in hosted activities. The collective creativity promotes integration in local societies, social cohesion, knowledge exchange, cultural tolerance and can reduce social instability. During the emergency time, public spaces are mainly used for providing shelter, gathering of people and distribution of services, goods and information. They accommodate basic emergency services and utilities, such as first aids, fresh water, electricity and communication. They are also used to build temporary shelters and camps.

Different types of public spaces have different capabilities for providing in emergency response. They compensate for each other when challenged by different risks. For example, small and medium open public spaces in high density areas provide a secondary support for evacuation and recovery assistance (Dionísio, Ota and De Souza 2012). These spaces usually have a high level of community belonging and thus, a social preparedness capability. Different functions of the public spaces and their integrated network provide diversity to the city fabric (Jayakody at al. 2016). This diversity makes the resilience of a city.

2.3. Blockchain technology as desirable alternative to the standard IT systems

Digital technologies can facilitate resilience in all tasks that require scale, efficiency, speed, interactivity and connectivity (Bhalla 2016). However, IT systems can be also compromised during crisis leading to exclusion from communications and lack of ICT access. Therefore, there is a need to improve the internet connected devices in security, reliability and resilience.

Blockchain technology has a potential to provide the resilient alternative to the standard IT systems, to maintain functionality and accessibility of the city systems in the face of external stresses and shocks (Biswas at al. 2016). The Blockchain is a linked list of blocks which contains data and a hash pointer which points to its previous block. It is used to record transaction of any value, whether it is money, goods, property, votes, etc and can be used in any project (Crosby at al. 2015). The main advantage of using Blockchain is that it is resilient against many threats and it has several unique features such as decentralisation, immutability, integrity, traceability and security (Sayer 2018; Kukeshova 2017).

There are a few conditions that indicate if blockchain technology is a viable solution. Multiple parties require interaction to share, change and verify sensitive data (PWC 2018). In this framework Blockchains are already used in various sectors including government, identity, culture, health, housing, energy, transportation, citizen participation, public safety. They provide different decentralized systems, peer-to-peer trading of resources, financial models, resource allocation, infrastructure for collecting, storing and sharing information across a network, digital identities, public participation, tracking, certification and fraud prevention and manage supply chains and platforms, which connect different services, adding greater transparency and security to all processes (Berryhill 2018; The Conversation 2016). The examples of Blockchains use cases are presented in Table 1 (Zoni 2018).

Table 1. The examples of Blockchains applications, addressing some aspects of resilience. (Source: own elaboration)

Application	Link	Details
Disaster preparedness and humanitarian relief		
FEMA	http://hagertyconsulting.com/about-us/blog/4527-2/	Financial recovery management
Building Blocks	https://www.technologyreview.com/s/610806/inside-the-jordan-refugee-camp-that-runs-on-blockchain/	Digital identities in refugee camps
unCHAINed	https://www.unchained.id/	Digital identities and resource allocation
Social actions		
Civil project	https://civil.co/	Empower journalists to engage with public
VoteWatcher	http://votewatcher.com/	Support electoral system
VotoSocial	http://votosocial.github.io/	Vote counting
Mobility		
DAV	https://dav.network/	Transportation services
Arcade City	https://arcade.city/	Network of local driver
Security of information		
KSI	https://e-estonia.com/solutions/security-and-safety/ksi-blockchain/	Government services
Enigma	https://enigma.co/	Control over personal data
Tracking		
Vote watcher	http://votewatcher.com/	Tracking
Alice	https://alice.si/	Transactions
SParts Projects		Tracking suppliers
Democratize finances		
Ethichub	https://ethichub.com/	Credit and investment
Climate Chain Coalition	https://www.climatechaincoalition.io/	To mobilize climate finance

In this framework, it is proved that Blockchains are also able to assist in managing social, governance and environmental risks and are already used to provide a system for disaster preparedness and humanitarian relief for transactions, verifications, security and communication (Hochstein 2017). It is already used to enable Human Rights initiatives to track individuals or rights violations (Galen D at al. 2018). It facilitates social platforms in public places for voting and citizen participation, supporting collaborative and inclusiveness practices (Iaconesi and Persico 2013).

It is noted that much more work is needed across a whole range of Blockchain issues, including speed, confidentiality, data protections, developing common protocols, and establishing regulatory and legal norms, as standards for Blockchain technologies (Barber 2016).

3. Methodology

The literature review on urban resilience, and the description of unique features and conditions of using Blockchain technology, provides the approaches used for the case study of the contribution of public places for building urban resilience in Volos (Greece). It addresses risk mitigation and emergency response practices in the urban environment in Volos (Xenokratis Plan) and the capacity of public places in Volos to adapt to different risks. It proposes measures to increase the adaptive capacity of public places in Volos using Blockchain technology.

4. Case study

Volos is a coastal port city in Thessaly and the administrative center of the Magnesia region. The Pelion mountain, with its own microclimate, affects the city's weather (City of Volos 2018). The area of municipality is 385.6 km2. It includes 9 municipal unit (Agria, Aisonia, Artemis, Iolkou, Makrinitsa, New Anchialos, Nea Ionia, Volos, Portania) about 27.678 km2 each (Wikipedia 2018).

The high density of buildings, in relation to the relative lack of open spaces is the characteristic of the recent urban fabric of the city. The City Plan of 2004 allocated 3.53% of the area of the city to public spaces, which corresponds to 7.02 m2 of public space per resident. The road network was given 22.9% of the area of the city, corresponding to 45.69 m2 per resident (Lalenis 2004). These provisions were also adopted in the Master Plan of 2017. Nevertheless, only 62 % of the area planned for public spaces is currently functioning as such, due to the lack of finance of the Municipality, and the complex bureaucratic procedures.

The central area (CBD) of Volos has the largest number of public places including sea promenade, and different types of squares and pedestrian areas. Chiliadou area has the largest number of small public parks. Karla has the largest municipal central park in the city. Nea Ionia – the poorest area of Volos- has only one public place, the square, adjacent to the church and many abandoned empty plots. Other areas have very few public places and no community life associated with them.

Public places in the city center and public places adjacent to the important public buildings (e.g. museums) have been maintained well, have some shading and occasionally were used by the local community. Squares, containing church are frequently visited by locals and tourists. Only some public parks provide facilities for different activities (e.g have benches, kiosks, play grounds and sport facilities). They are well maintained and visited by different social groups. Small squares, adjacent to main streets, have good greenery for shading but have no benches and poor maintenance.

4.1. Preliminary Hazard Risk Assessment for Volos

Preliminary Hazard Risk Assessment for Volos identified a number of risks, affecting the city, including earthquakes, floods caused by flash rains, fires, air pollution, drought in summer time and social risks. Municipality of Volos considers earthquake as a main hazard for the city, mainly because of the traumatic experience of the earthquake of 1952 and the general perception that earthquakes cannot be predicted or prevented.

The combination of factors including the geography of Volos, three rivers (Xerias, Krafsidonas and Anavros) crossing the city and climate change associated with increased rain falls and poor flood management, caused frequent river floods in Volos in the past. In 1956 there was a big flood of Anavros.

After this flood banks of rivers were raised. The water collector was built in 1962 to collect an excess of water from Anavros.

The industrial area, at the mouth of Xerias, is lower that the sea level and have regular floods. There are no residences there and therefore no flood mitigation measures have been proposed. Flood maps, predicting increased flooding of Xerias in 50 and 100 years were produced by Papaioannou at al. (2017), pointing that flooding will be one of the main hazards for Volos in future in its central and eastern part. Thus, further flood mitigation plans associated with climate change are urgently required.

Air pollution from the cement factory and its waste burning facilities at the east part of the city is a serious health hazard for local population.

4.2. Xenokratis Plan as the main emergency framework of Municipality of Volos

Xenokratis Plan is a general emergency framework of the Ministry of Internal Affairs of Greece. It is produced for a period of two years and is renewed every two years. For Volos Municipality Xenokratis Plan it focusing on earthquakes and seismic phenomena. Other existing and potential risks including climate change risks and risks of social nature, are not covered.

The Plan includes characteristics of earthquakes, identifies risk mitigation strategies, emergency response and responsible civic and administrative departments. It focuses mainly on administrative procedures and its main points of reference are sectors and departments of the administration and the wider public sector. It describes hierarchy of departments in risk mitigation and emergency response and levels of their responsibilities, and provides lists of duties of the Local Government to prepare and execute the Local Xenocratis Plan during and after earthquakes.

The main part of Xenocratis Plan contains instructions concerning provision of food, water, means of transportation, fuel, temporary shelters, medical supplies, machinery for removing the ruins, provision of provender and mash, sanitary provisions and means for communication. Special information is provided with emergency telephone numbers and a list of volunteer organizations.

The Plan is particularly weak as it concerns its spatial dimension. There are no evacuation maps included in the plan. Instead, a list of open / public spaces and evacuation routes to transfer the population away from the city towards Larisa and Pelion is provided, accompanied by a list of vehicles to be used for transportation and for the removal of the ruins.

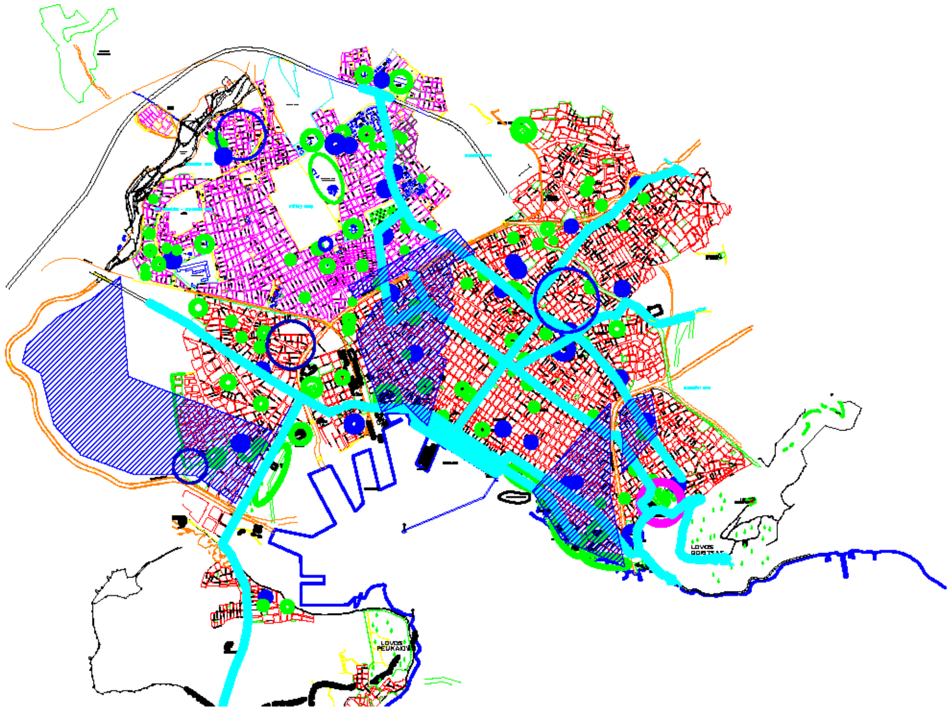
Xenocratis Plan has not been taken through any public consultation procedure. It exercises a poor top down approach to communication of mitigation and emergency response plans to the population. The responsible departments fail to provide adequate information and implement training of the local population as described in the Plan.

Digital technologies as essential tools to facilitate risk mitigation, emergency response and adaptation after crisis have not been considered in Xenocratis Plan, except general suggestions about the significance of unimpeded information flows between all affected and related parties.

4.3. The role of the public places for risk mitigation, emergency response and adaptation in Volos

Xenocratis Plan considers public spaces in Volos as the main providers of shelter and spaces for gathering during evacuation. An analytical plan of existing resilience framework of the city (Figure1) was produced, showing the existing evacuation provision, evacuation roots, distribution of public places for gathering (open spaces, school yards, stadiums and open sport facilities) and their vulnerability in case of floods. The plan also shows the most vulnerable neighborhoods in Volos, which are likely to be affected during crisis.

Figure 1. Analytical plan of existing resilience framework of Volos (Source: Master Plan of Volos (2016) and own elaboration)



Main challenges associated with the existing resilience of public spaces in Volos were identified as follows:

- Public places in Volos fail to support different city needs, provide alternative facilities and functions and thus, they have low resilience in respect to risk mitigation and adaptation capacities.
- There are high densities of buildings and relative lack of open spaces. There is an inadequate diversity and unequal distribution of public places in the different areas of Volos (fewer in the poorest neighbourhoods –such as Nea Ionia- and in the central area with high building ratios). Seafront promenade is considered the main location for recreation, and socializing.
- Xenocratis Plan does not provide evacuation maps with open / public spaces for emergency gathering, access roads to the emergency refuge spaces, or collector roads to transfer the population away from the city.
- Xenocratis Plan provides a poor selection of public places for evacuation. Criteria for selection do not include level of permeability, tree canopy, population density, capacity for multiple use, typography, accessibility and connectivity with the main evacuation roots. Primary and secondary places for gathering are not identified.

- The nature and extent of possible risks due to climate change (flooding) and risks of social nature, are not identified by Xenocratis Plan. Flood zones are not considered in the evacuation plan and some places for gathering during earthquake have high risk of being flooded.
- There is poor data availability, communication, information and implementation of risk mitigation practices. There is no publicity about evacuation plan in Volos.
- There are low investments in risk mitigation programmes.
- The social role of public places in risk mitigation and risk management is undervalued. There are no related community events and social groups associated with public places in Volos. Public activities are usually held in the streets of Riga Fereou and P. Mela, the square around St Nikolas church and central pedestrian area of Volos.

4.4. Opportunities of Blockchain technology to strengthen resilience in public places in Volos

Blockchain technology is able to facilitate all levels of resilience in Volos, improving coordination of emergency services and evacuation, and change the way in which the resources are distributed, valued and traded. Blockchains can facilitate any type of efficient and cost saving transactions, where multiple parties require interaction, with transparency, immutability, decentralization, security and integration. It can strengthen social capacity (manage community networks), institutional capacity (support Xenocratis Plan and improve communications between specific institutions), environmental capacity (strengthen existing ecosystem management) and economical capacity (manage budgets) of Volos (Table 2).

Table 2. Blockchain technology for strengthening resilience in Volos. (Source: own elaboration)

Resilience Framework		Blockchain technology for resilience:
Risks mitigation	Social & Institutional Capacity	• Coordination and management of risks and institutions (Xenocratis Plan), distribution of resources • Legislative framework • Administrating, collecting, protecting, storing, monitoring and sharing information and databases. • Register & certification • Build social capacities and public participation: Build alliances and inclusive networks Community response groups Engage and civil society organizations Voting platforms Co-Creation
	Financial Capacity	• Manage budgets for resilience, distribution of resources • Security transactions • Fraud prevention

	Support urban development and design	• Facilitate urban planning and land-use management • Conduct vulnerabilities mapping • Conduct urban master plan updates and sectoral strategies
	Environmental Capacity	• Raise awareness of the impacts of environmental change • Provide management, coordination, administration of ecosystems
Emergency response	Anticipation Preparedness Subsidiarity Information Integration Cooperation Continuity	• Monitoring, reporting, registering and verification Manage resources, risks and update preparedness plans and communicate to all stakeholders • Manage priority services (evacuation, connectivity, communication, information, medical supplies, shelter, • Administration and data management • Manage supply chains • Secure aid and transactions • Provide information management systems at all levels
Recovery		• Manage provision of shelter, food, water, communication • Manage supply chains • Manage budgets and secure transactions • Processing of insurance claims

Blockchains combined with the standard IT systems could enhance participatory democracy on the local level, by enriching methods of consultation, and encouraging participation of higher numbers of people and diverse social groups. Blockchain-based grants management can ensure that grants for resilience are spent for the right purposes. It can include any type of registration and life cycle management, insuring the increased accuracy in record keeping.

As it concerns public spaces in Volos, Blockchains can strengthen social inclusion for disaster mitigation, emergency response and social adaptation by creating transparent models for citizen engagement, public participation, supporting community response groups, engaging local groups with civil society organizations and facilitating place making. They can support place making by co-creation platforms, registry of monuments and places of interest, ticketing for visiting places and events and creating learning opportunities in public places.

5. Conclusions

5.1.. The study proposes that city resilience to existing and emergent threats is successful, if the offset method is used on the level of the city as an integrated system, where different structures, areas and parts are interconnected and compensate for each other when challenged by different risks. Therefore, diversity and multi-functional characteristics of public spaces and city systems provide sustainable resilience.

It is suggested that public places can be considered as useful tools for risk mitigation, emergency response, recovery, and adaptation before, during and after crisis, if they have social, economic and environmental capacities. In particular, strengthening social capacity of public spaces and building place capital through inclusive practices and collective creativity, contribute to resilience of the public places in the face of both climate risks and social crises. During an emergency, public spaces are mainly used for provision of shelter to affected population, and distribution of services, goods and information. In cases of social crises public spaces shape the relationship between local community and affected social groups and contribute to creating an accepting environment for the victims of crisis, reducing their vulnerability, mitigating their impacts on host communities and facilitating integration in host communities.

5.2. This case study argues that there is a deficiency of risk mitigation and emergency response practices in Volos and low capacity to adapt to different anticipated and unexpected risks.

Xenokratis Plan is the only existing risk mitigation and emergency framework for Volos. It facilitates partial resilience of the city, proposing the evacuation plan during earthquakes and focusing mainly on administrative procedures for risk mitigation and emergency response. The nature and extent of possible climate change risks and risks of social nature have not been identified by Xenocratis Plan. Flood zones are not considered in the evacuation plan and some places for gathering during earthquake have high risk of being flooded.

Xenocratis Plan does not have a spatial dimension and contains only a list of public spaces for evacuation and main collector roads. It considers public spaces in Volos as main providers of shelter and gathering of people during evacuation. The selection of public places for evacuation is not based on building ratio of the area, available space, accessibility, connectivity to the main collector roads and flood zones. It did not provide an adequate number of evacuation places in the poorest neighbourhoods of Volos (e.g Nea Ionia) and in the central area with high building ratios. Primary and secondary places for gathering were not identified. There are many abandoned sites in Volos, which should be cleared of rubbish and considered as secondary gathering places in case of crisis. They can increase an adaptive capacity of Volos to mitigate climate change and social risks.

Xenokratis Plan and risk mitigation plans of the municipality for building resilience of the city are not communicated to the public.

The social role of the public places in risk mitigation, risk management and adaptation in Volos is undervalued. There are no community events and social groups associated with public places. Only few public places have been well maintained. Most of them fail to support different city functions and thus, to contribute to city resilience.

5.3.. The study proposes the strategy to reinforce the resilience of public places in Volos, which should include:

1. Increasing the number, diversity, accessibility and connectivity of public spaces in Volos.
2. Providing public spaces in Volos with the sustainable qualities of resilience.
3. Strengthening social inclusion of public spaces.
4. Improving Xenocratis plan for evacuation and mitigation plans of Volos, addressing all risks affecting the city including social risks.
5. Digital Inclusion through the adoption of innovative IT systems, and in particular, the implementation of Blockchain Technologies.

5.4. The current study proposes that Blockchain technology have a potential to provide the resilient alternative to the standard IT systems due to its unique features such as decentralisation, immutability, integrity, traceability and security. These features are particularly useful in facilitating all levels of urban resilience, providing independent infrastructure for managing, protecting and administrating information across a network, communication, and fraud prevention. It is a viable solution for all applications which require interaction and need to share, change and verify sensitive data, and consequently, facilitate coordination, management, implementation and dissimilation of Xenokratis plan in Volos.

The case study argues that Blockchain technology may further add to the potential of urban public spaces to enhance urban resilience in Volos. It can strengthen social, institutional, environmental and economical capacities of public places. In particularly, it can improve social capacities and social adaptation in public spaces by creating models for community participation, supporting community response groups, engaging local groups with civil society organizations and facilitating place making.

Conflict of Interest

The authors declare no conflict of interest.

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