Application and Challenges of Web 3.0 in Smart Cities

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Abstract
Citizens are becoming more directly involved in the advancement of sustainability in smart development in areas where web 3.0 promises to transform urban cities into advanced smart cities and where ICTs are integrated in strategies for participation and co-production. This study's aim is to investigate and pinpoint the applications and difficulties in using Web 3.0 technologies in smart cities in Lithuania. A systematic questionnaire with open-ended questions was created after a thorough study in order to elicit 250 replies from citizens, managers, and online workers in Lithuania. The information gathered was examined. Our research findings in this paper offer a multidisciplinary understanding of web 3.0's applications and difficulties in smart cities, as well as insights into the chances for citizen participation in decision-making and service delivery. Future cities will likely need a stronger technological connection with smart technology, with an emphasis on the rising role of the digitally "empowered" citizen. In order to improve surroundings in web 3.0 contexts, this study examines the difficulties and applications of implementing such a futuristic idea. It will be said that although much of the technology needed to realize the vision of Web 3.0 applications in smart cities is already available, further research is still required in several important areas.

Keywords: ICTs, technology, Lithuania, dificulties.

1. Introduction
A new way of thinking about the relationship between globalized communication and the means of sending information through safer, quicker, more effective means and forms is necessary since the informatization of the technology system has become the topic of significant changes in society. Being able to access global trends in higher systems has been made possible by Web 3.0's quick development, which has benefited more environmental chances. The necessity to grasp digital tools like web apps has made it possible for us to envisage teaching practice in the 21st century and how equipped it is for the use of information and communication technology (ICT). Today, sudden changes have compelled quick technological evolution [1]. In light of the aforementioned, in a worldwide world where web applications are essential to the educational process, there are new ways to teach and learn equally. ICTs have developed into a crucial and essential component for the creation of an environment that is suited for both teachers and pupils [2].

Utilizing smart city technologies to engage citizens and offer them direct access to the co-production of services and policy has recently gained more attention [3]. They claim that by doing this, they will be able to exert influence and control over how public services are delivered and ensure that those services are delivered in a way that advances their interests [4]. The term "smart cities" refers to these modern electronic-mediated agreements and activities [5]. The use of ICTs is a "positive thing" and is a desirable activity for governments and individuals to actively engage in, according to normative perspectives that have historically dominated studies on citizen involvement [6]. In fact, tensions arise when individuals and governments do not share a common interest in cooperating, and citizen participation is more nuanced, varied, and affected by a range of events and situations [7].

In accordance with this, the widespread use of the internet has given rise to a number of proposals, including those involving smart or intelligent digital, wireless, cybernetics, or knowledge. Of these, the term "smart city" has experienced the most development, making it impossible to ignore its impact on work at all levels and modalities [8]. Thus, adopting a blatantly formative strategy that frequently even sounds soporific and prevents each citizen's training from fostering healthy cognitive growth. This also includes digital competence beyond the advantages that it offers in the long and short term as a leisure activity for implementing web 3.0, which creates an innate learning environment, as digital competence creates advantageous variables [9]. In order to identify emerging themes of application and challenges of web 3.0 with the components of technologically mediated Smart cities, we analyze in this article the role of citizen participation in processes of Smart cities. It is evident that e-Participation processes and citizen motivation in the co-production of services and policy via ICTs are poorly understood. We propose several technological approaches in order to reciprocate the wise use of web 3.0 by municipalities and to better understand how and why citizens are driven and incentivized in this process. This strategy is a "fresh take" on the Smart city concept and highlights the conditions essential for municipalities and residents to experience reciprocal advantages and outcomes in a setting where relationships are mediated by new technology.

1.1. Evolution of Web 3.0

In order to understand where the Web is heading and what impacts it will have on businesses and cities, it is essential to characterize the many stages of the Web's evolution. Differentiating between the various Web stages was difficult [10].

1.1.1. Web 1.0

The Web 1.0 framework made it possible to post content in a static format with text and images [11]. There was no interaction between the user and the material; it was depicted as static data and information that was just displayed. Content could only be read by users, not created.

The Hypertext Transfer Protocol (HTTP) and the Hypertext Markup Language were the protocols of this generation (HTML). The HTTP protocol is used to transmit data between a Web server and a Web browser. The HTTP protocol delivers text, graphics, and images to the browser, which the HTML protocol then instructs on how to display.

1.1.2. Web 2.0

The main distinction between Web 1.0 and Web 2.0, rather than solely the Web's supporting infrastructure, is users' ability to create, distribute, and interact with content on the Web, claims [12] in an effort to explain the paradigm change. As a result of new technological capabilities, consumers can now create and distribute information. [13] asserts that the growing cooperation among users, programmers, service providers, and corporations is what makes it possible for them to reuse content. In order to improve the user experience, Web 2.0 applications can mix and match Web content and services [14]. This sharing was made possible by internet software that could provide rich user interfaces that could be used on any platform or device without the need for extra software installation.

1.1.3. Web 3.0

Instead of the creation of a brand-new web, Web 3.0 is an expansion of the technology seen in Web 2.0. The variety of content on the internet is expanding, and more data is being freely accessible [15]. The Web is evolving into a platform for data linkage, and when similar-quality data is linked together, the value of the original data increases [16]. Computers still are unable to fully automate the functions of collecting this data or using it to carry out complicated operations. For the Web to advance to the next stage, data integration and organization are essential. As with earlier iterations of the Web, there isn't universal agreement on what Web 3.0 is [17]. Web 3.0, Semantic Web, Transcendent Web, and Web of Things are a few names for it (henceforth collectively referred to as Web 3.0). Even though these expressions go by different names, they all refer to the same fundamental concepts. [18]. claimed that in Web 3.0, fresh information is produced by computers rather than by people. This is corroborated by the fact that [19] that data integration is the fundamental tenet of Web 3.0 and that by utilizing metadata (a term used to describe data within data, which provides information about an item's content) embedded in Websites, data can be transformed into useful information and be located, evaluated, stored, or delivered by software programs known as Intelligent Agents (IA's), which are programs created to collect information based on users' interactions with the Web.

Web 3.0 will eventually involve an integrated Web experience where computers will be able to comprehend and organize data similarly to humans. In order to link data with comparable features and conveniently obtain consumer-specific data, the collected data will be organized into hierarchical categories. This will make it possible for any format of data to be shared and interpreted by any device over any network in a global data warehouse. Organizations lack the knowledge necessary to define web 3.0 in smart cities, generate value from it, or regulate it as new technologies are adopted.

2. Applications and Mechanisms of Web 3.0 in Smart Cities

The Web is a valuable resource in today's business and other surroundings, and Web 3.0 with mechanism-annotated content in cities will be much more important for fulfilling information-based tasks. The introduction of a variety of cutting-edge participatory places where the physical and the digital are combined and where individuals may actively participate in processes that influence public services and policy is credited to the web 3.0 in smart cities. By combining the digital space, such as cloud computing, block-chains, AI, data driven science, semantic web, and mechanisms spaces, such as Hackathons, Living labs, Fablabs and maker spaces, Smart urban labs, Citizens' dashboard, Gamification, Open data, and Crowdsourcing, Web 3.0 has the potential to become the hub for every information resource, person, and organization, as well as all related activities [20].

2.1. Mechanisms of web 3.0 in Smart city

The Smart city mechanism, which is credited with developing a number of imaginative participatory spaces where the physical and the digital are integrated and through which citizens can actively engage in processes that shape public services and policy, provides many illustrative examples of these "spaces" [21]. A few of these are hackathons, living labs, fablabs, maker spaces, Smart City Labs, citizen dashboards, and Smart Citizen Labs. Others include crowdsourcing, gamification, open datasets, and crowdsourcing.

Table 1. Mechanism space of web 3.0

Types	Descriptions
Hackathons	To help address ongoing city issues, teams of programmers, designers, computer club members, and Small and Medium-sized Enterprises (SMEs) collaborate to create software solutions or applications using open data. Hackathons are held to demonstrate a municipality's commitment to an inclusive, open system [22].
Living labs	ICT-related product development, prototype testing, and idea generation are done in living laboratories where participants contribute their thoughts, knowledge, and skills along with those of other participants and industry professionals. The users of the living lab shape "the innovation in their daily real-life contexts" [23], which can either be a physical or virtual reality.
Fablabs and maker spaces	Fabrication laboratories, or fablabs, are a type of living lab that place an emphasis on community-based shared learning and the creation of either tangible commercial products that frequently use recycled materials in their physical production or solutions to societal problems using ICTs (and frequently social media) [24]. Maker spaces are a type of fablab where technology experimentation can be done inside of a lab but with the opportunity for collaborative learning that extends outside of the city [25].
Smart urban labs	Another type of living lab, smart urban laboratories are usually at the city scale, with an emphasis on innovation and involve testing ideas and products by corporations, the government, and residents. Common sustainability components include sustainable "living, working, and mobility" [26].
Citizens' dashboard	An interactive "app" called a citizens' dashboard can be found on a mobile device, tablet, laptop, or computer. It allows users to comment on urban issues or sustainability concerns and makes public information sources like traffic jams, air quality, walking and cycling routes, open data sources, and online connectivity available [27]. Open data can be accessed through citizen dashboards to provide crucial performance information, allowing for deep analysis [28].
Gamification	Gamification of public services, which capitalizes on the ostensibly rising use of gamification technology in people's daily lives, is increasingly being used to encourage residents to participate in co-production as a means of giving answers to urban problems. Depending on how much activity a citizen produces, they may adopt a "identity" and be "ranked" [29]. Gamification and its potential use in public services extend beyond videogames.
Open data	Making publicly accessible datasets containing anonymized statistical, performance, or demographic data generated by public bodies, such as those related to employment, housing, health, education, welfare, crime, transport, or simply the provision of services, is known as open data, a term that is frequently used incorrectly.
Crowdsourcing	Crowdsourcing is a Web-based engagement model that collects online feedback from members of the public (the "crowd") about a particular social issue, such as a public planning issue or recommendations by a municipality to potentially engage in a particular activity or potential investment, such as investing in cycling infrastructure. The invitation to interact and participate might be extended to particular groups or it can be extended to everyone.

Through Web 3.0 and IA, processes will become more automated, providing information much more quickly and precisely at a greater degree of access [30]. With its enhanced capabilities, Web 3.0 will enable robots to categorize data and add meaning, potentially boosting its use in smart cities and opening up new possibilities. Web 3.0 services relate to static information in this context of use in smart cities and allow the user to interact and contribute information.

2.1.1. Web 3.0 -Opportunities in Smart Cities

Smart cities can take use of a number of opportunities presented by Web 3.0 to boost productivity and efficiency. Organizations need to be ready to learn about the advantages and disadvantages of Web 3.0 technologies, according to [31] Automation of procedures, considerably faster information production, and increased access are some of the major potential provided to businesses, particularly cities. In order for these businesses to review raw data and transform it into valuable information, which would improve their decision-making processes, citizens may, for example, use cloud computing technology. Big data is information that is created mostly by machines in the so-called "internet of things," as opposed to just humans or Web 3.0 technology.

Nine out of 10 firms have already characterized their organizations as data-driven and large organizations and cities have the capacity to benefit from big data. The first three production factors are land, capital, and labor; the fourth is information. Our cities' success and sustainability depend on innovation [32]. Therefore, it is necessary to be ready to use Web 3.0 technologies in order to benefit from the enormous potential provided by the introduction of big data processing in web 3.0. Web 3.0's goal from an e-commerce standpoint is to take advantage of the vast social web network. Using new and improved techniques for analyzing internet users' habits, it is possible to learn more about the unique interests of the client (both inside and outside of their present activity) and to give them a highly tailored e-commerce shopping experience [33].

2.2. Web 3.0 -Challenges for Smart Cities

In order to fully utilize the potential of technical breakthroughs, the infrastructure for the Internet and information technology (IT) must be completely rebuilt for Web 3.0. As a result, enterprises and citizens must be ready to make changes to their current infrastructure. Using Web 3.0 technology presents a number of difficulties, including a higher risk to data privacy due to varied privacy laws around the world. Due to the nature of the semantic web and the ambiguity and uncertainty associated with the use of Web 3.0 technology, users who intend to use Web 3.0 apps may encounter additional challenges.

The rapid evolution of Web 3.0 has presented difficulties for researchers working to create standards that would be accepted globally [34]. More difficulties were covered by [35] and [36].

2.2.1. Issues Concerning Mass Adoption

Not everyone is familiar with web technology or the decentralized web given the current state of affairs. The majority of internet users are not likely to be in favor of a hasty modification. The decentralized web needs people to be ready to adapt before it can truly be a revolution. The public generally likes the centralized social media platforms that are now in use, such as Facebook and Twitter. One major worry is that some people would be against the idea of using a blockchain-based application to replace the current platform. The decentralized web won't be adopted by everyone based just on its technical viability. Unless they have a compelling personal need for the decentralized web, people may decide to preserve things as they are [37].

- Privacy of data: Due to the variance in privacy regulations between nations, there will be a greater risk of data privacy in the MashUps of the connected world in the future;
- Security risks: According to Weippl and Ebner in [38], high privileges and a lack of server-side checks can provide security issues;
- Special needs: It will be more difficult to make web content accessible to people with special needs, similar to other web-based apps.

2.2.2. Lack of standards

This has to do with the transmission of content and data between systems. The sharable course object reference model (SCORM), the IEEE learning technology standards committee (LTSC), the Instructional Management Systems project (IMS), and other projects, for instance, will need to be enhanced for the upcoming web.

2.3. Ethical dilemmas

A proponent of the "P3E" model of pedagogy—personalization, participation, productivity, regional ethics, citizen's ethics, and organizational ethics—argues that the emergence of smart technology management systems greatly increases ethical quandaries. Prior, Rogerson, Silva, and Costa in [39].

2.3.1. Multilingual web

Some web 3.0 models lack interoperability and are not standardized, which makes it difficult for users to use them because they prefer simple and static software. There is presently no practical translation of information. The implementation of the Multilingual Web is also hampered by the high cost of translation and specialized knowledge, which, when combined with the fact that language is a living thing, eventually results in translations that are no longer accurate if the software is unable to advance. If the language is updated, this also affects the quality of the content itself.

- Vagueness: According to [40], the Semantic Web's difficulties of vastness, vagueness, uncertainty, inconsistency, and dishonesty will have an impact on smart cities.

3. Method

This study is interpretive, exploratory and qualitative in nature and was conducted using empirical study approach. The study research is well suited for answering these types of research questions while we use Google form, which could be completed from a Windows, Mac, or smartphone device using a web browser. We study the application and challenges of web 3.0 in smart cities. The sample question expects 250 responses from citizens of public areas that are engaged or disengaged with smart technologies in Lithuania. Likert-type surveys with items for the variable web applications 3.0 and items for obstacles served as the data collection method and tools. Apps and difficulties in smart cities were the two elements of the 3.0 web applications questionnaire. The confidentiality of the data was ensured by making participants aware of the importance of their involvement. The SPSS (version 25) program was used to carry out the statistical analysis. The estimation of the logistic regression models, for the determination of the determination coefficient, took into consideration the exploratory factor analysis to ensure the validity of the constructs.

3.1. Result

Model 1: Application of Web 3.0 in Smart Cities

The value of R, the multiple correlation coefficient, is shown in the "R" column. R is regarded as one metric for the accuracy of the dependent variable's prediction. A value of .856 in this study indicates a good level of prediction. The "R Square" column represents the R 2 value (also called the coefficient of determination), which is the proportion of variance in the dependent variable that can be explained by the independent variables. You can see from our value of .733 that our independent variables explain 73.3 % of the variability of our dependent variable and 26.7% (100%-73.3%) of the variation is caused by factors other than the predictors included in this model. To accurately report the data interpretation of "Adjusted R Square" (adj. R2) is another important factor. A value of .722 (table 1) in this study indicates true 72% of variation in the outcome variable is explained by the predictors which are to be kept in the model. High discrepancy between the values of R-squared and Adjusted R Square indicates a poor fit of the model. The standard error (.544) of a model fit is a measure of the precision of the model. It is the standard deviation of the residuals.

Table 2. Model summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.856[a]	.733	.722	.544

Source: Author own work

Table 3. Anova Test for Independent Variable

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	193.789	10	19.379	65.592	.000[b]
	Residual	70.611	239	.295		
	Total	264.400	249			

Source: Author own work

a. Dependent Variable: AP1

b. Predictors: (Constant), AP11, AP9, AP6, AP8, AP2, AP4, AP10, AP5, AP3, AP7

The F-ratio in the ANOVA (Table 2) tests whether the overall regression model is a good fit for the data. The table shows that the independent variables statistically significantly predict the dependent variable, $F (10, 239) = 65.592$, $p (.000) < .05$ (i.e., the regression model is a good fit of the data).

Table 4. Coefficients for Independent Variable

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.385	.239		5.800	.000
	AP2	.426	.067	.484	6.318	.000
	AP3	.379	.075	.472	5.025	.000
	AP4	-.512	.088	-.487	-5.818	.000
	AP5	.337	.086	.338	3.898	.000
	AP6	.168	.090	.146	1.872	.062
	AP7	-.144	.081	-.183	-1.773	.077
	AP8	-.129	.054	-.154	-2.397	.017
	AP9	.291	.061	.353	4.739	.000
	AP10	-.310	.070	-.303	-4.407	.000
	AP11	.189	.067	.232	2.811	.85

Source: Author own work

a. Dependent Variable: AP1

Shows regression model parameter estimates, as well as corresponding standard errors, t-statistics, and p-levels. Since empirical significance levels are less than 0.05 for independent variables AP2 (Use of hackathons), AP3 (residents digital literacy), AP4 (Digital competency of citizens), AP5 (Citizen autonomy and accountability) AP8 (Representation of citizenry by web 3.0) and AP9 (Smart business innovation) variables are significant at 5% level of significance.

This implies that the variables AP2, AP3, AP4, AP5, AP8, and AP9 are significant predictors of the dependent variable AP1 (Which is the application of Web 3.0 technology in smart cities).

On the contrary AP6 (New smart agent tactics), AP7 (The use of ICT by engaged citizens and disengaged citizens), AP10 (ability to communicate and interact in social and personalized ways) and AP 11 returns P-values higher than our accepted 5% level of significance, hence they are statistically insignificant based on the evidence available in this study.

Table 5: Challenges of Web 3.0 in Smart Cities

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.856[a]	.733	.728	.411

Source: Author own work

a. Predictors: (Constant), C6, C4, C2, C5, C3

Table 4 shows the results of the predictive variables multiple regression analysis R Square .733 The R Square in a multiple regression represents explained variance that can be contributed to all the predictors in a progression. The R Squared gives explanatory power. In Table 4 the Model Summary shows the R Squared of .733 (.733 x l00= Adjusted R

Square is 73.3%) or 73.3% of the variance in the dependent variable (Challenges of Web 3.0 in smart cities.

Our adjusted R Square" (adj. R2) is another important factor. A value of .728 in this study shows true 72.8% of variation in the outcome variable is explained by the predictors which are to be kept in the model. High discrepancy between the values of R-squared and Adjusted R Square indicates a poor fit of the model as earlier stated. The value of our standard error of estimate which measures the standard deviation of residuals is 0.4.

Table 6. Anova Test for Dependent Variable

ANOVA[a]						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	113.664	5	22.733	134.264	.000[b]
	Residual	41.312	244	.169		
	Total	154.976	249			

Source: Author own work

a. Dependent Variable: C1
b. Predictors: (Constant), C6, C4, C2, C5, C3

The F-ratio in the ANOVA (Table 5) also tests whether the overall regression model is a good fit for the data. The table shows that the independent variables statistically significantly predict the dependent variable F (5, 244) = 65.592, p (.000) < .05 (i.e., the regression model is a good fit of the data)

Table 7. Coefficients for Dependent Variable

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.479	.118		12.486	.000
	C2	.389	.032	.561	12.144	.000
	C3	.126	.053	.204	2.401	.017
	C4	.073	.032	.097	2.323	.021
	C5	-.064	.049	-.105	-1.312	.191
	C6	.138	.051	.220	2.724	.007

Source: Author own work

a. Dependent Variable: C1

Table 6 gives us the summary of the contributions of our predictors to our model (Challenges of Web 3.0 in smart cities), as can be seen the predictors C2, C3, C4, and C6 are significant given that their p-values are less than 5. This also implies that the predictors C2 (privacy laws), C3 (Nature of semantic web, vagueness), C4 (rapid pace of development of Web 3) and C6 (vastness, ambiguity and uncertainty) are major contributors to the challenges of Web 3.0 in smart cities.

However, predictor C5 which measures security risk returns a p-value of 0.191 which is greater than our accepted significance level of 0.05, hence it is empirically non-significant in this study.

3.2. Discussion

The goal of this study was to explore and identify both the advantages and drawbacks of implementing Web 3.0 in smart cities. This study identified some of the key Web 3.0 processes and apps required to build smart cities. Due to a paucity of resources, both organizations and leaders must innovate. Hackathons, resident digital literacy, citizen digital competency, citizen autonomy, and accountability of representation of the citizenry, however, are significant variables that this study identified as themes of web 3.0 applications and development functions in smart cities, according to our results. This suggests that these factors are important for using Web 3.0 in smart cities. On the other hand, according to the data from this study, new smart agent strategies and the use of ICT by both engaged and disengaged individuals to improve the ability to communicate and interact in social and personalized ways within the cities are statistically negligible. This means that fundamental obstacles to Web 3.0 adoption in smart cities include privacy restrictions, the nature of the semantic web, ambiguity, and the rapid pace of Web 3.0 development. Measures of security risk, however, are not empirically significant in this investigation.

The findings of this study will aid in the planning and development of short- and long-term information systems strategies for creating or achieving smart cities by government and organizational leadership.

3.3. Implication

Emerging technologies like Web 3.0 applications have the potential to significantly improve smart cities in developing nations. Through the best possible use of their information technology resources, leaders will be able to improve the workings and competitiveness of businesses and cities. In the context of developing nations with increasing economies, such as cities, the applications and challenges of adopting Web 3.0 technology have not been studied. Technologies used in Web 3.0 are categorized as emerging technologies. This study will be a valuable addition to the few studies that have been written about the potential advantages and difficulties of using Web 3.0 applications in smart cities.

3.4. Conclusion

It is obvious that contextualized application of web 3.0 in Smart Cities are solutions required given the variety of city contexts such as economic, cultural, social, political, organizational, and technological and challenges such as (political, governmental, social, and cultural), risks (such as organizational, implementation, and human capacity), and implementation goals (such as objectives, policies, management, and technology) found in our analyzed initiatives.

Smart cities are at the nexus of diverse data flows from new sensory devices, existing databases, and big data activities. They present intriguing opportunities for citizen involvement in co-production and service redesign, as well as in influencing the agendas and practices of public policy. The use of open datasets, hackathons, and living labs are just a few of the cutting-edge citizen engagement initiatives included in this study. Many of these practices are related to the experimental character of Smart cities in that they are tiny activities involving very few residents and service users.

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