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Abstract

Abstract_EN

Citizen participation in the urban planning process and decision-making is considered one of the main pillars of the development of sustainable cities. The concept of sustainability, which has a broad and multidimensional meaning, plays a fundamental role in urban planning and serves as a key principle for achieving environmental, economic, and social balance in urban development. In this context, civic participation is recognized as a human right that encompasses various dimensions, including economic, cultural, social, and political. The engagement of citizens in different phases of the urban planning process contributes to increasing the legitimacy of policies and projects undertaken, ensuring essential principles of democracy, such as transparency and equality. Therefore, developing genuine strategies that ensure real citizen participation should be regarded as a fundamental principle, as this approach can strengthen the sense of belonging and foster cooperation among different societal groups, thereby enhancing social cohesion.

But, today, the world is undergoing significant changes driven by various factors, including rapid urbanization, climate change, political issues, and socio-economic inequality, which has increased the complexity of urban life and presents planners with major challenges. In these conditions, it has become a necessity for the city to function as a single structured system that manages to address key urban issues in a strategic manner with the aim of achieving sustainability and the highest possible social well-being. Thus, technology emerges as a mechanism that enables cities to face these challenges more effectively. Technological transformations have brought numerous benefits, marking a shift from traditional planning methods to innovative approaches based on the functionalities offered by technology, especially artificial intelligence (AI) and machine learning (ML). In this sense, AI and ML should not be seen only as technical tools but also as essential instruments for the effective functioning of social, economic, and political structures in the city.

Given this context, the present research proposes a citizen communication system based on natural language processing (NLP) with the aim of involving citizens in the planning process. Data collection consists of a dedicated pipeline, starting with social media and questionnaires and data processing in the native language. The lack of specific libraries for the Albanian language has dictated the construction of a new system, offering a more realistic reflection of the sentiment expressed by citizens and showing the technology's potential to fill structural gaps in the data.

Furthermore, this study analyses two urban issues through the application of ML and AI techniques. Findings were evaluated from both citizens' and experts' perspectives, highlighting the benefits of data-driven approaches to urban planning. Furthermore, the developed communication model introduces a new structured approach that bridges theoretical models of participatory planning with their practical application, grounded in community needs and demands.

Keywords: participatory planning, artificial intelligence, machine learning, NLP, smart city, sustainability

Abstract_IT

La partecipazione dei cittadini al processo di pianificazione urbana e al processo decisionale è considerata uno dei pilastri principali dello sviluppo di città sostenibili. Il concetto di sostenibilità, che ha un significato ampio e multidimensionale, gioca un ruolo fondamentale nella pianificazione urbana e funge da principio chiave per il raggiungimento dell'equilibrio ambientale, economico e sociale nello sviluppo urbano. In questo contesto, la partecipazione civica è riconosciuta come un diritto umano che abbraccia diverse dimensioni, tra cui quella economica, culturale, sociale e politica. Il coinvolgimento dei cittadini nelle diverse fasi del processo di pianificazione urbana contribuisce ad aumentare la legittimità delle politiche e dei progetti intrapresi, garantendo principi essenziali della democrazia, come la trasparenza e l'uguaglianza. Pertanto, lo sviluppo di strategie concrete che garantiscano una reale partecipazione dei cittadini dovrebbe essere considerato un principio fondamentale, poiché questo approccio può rafforzare il senso di appartenenza e promuovere la cooperazione tra i diversi gruppi sociali, migliorando così la coesione sociale.

Tuttavia, oggi il mondo sta attraversando cambiamenti significativi guidati da diversi fattori, tra cui la rapida urbanizzazione, il cambiamento climatico, le questioni politiche e la disuguaglianza socio-economica, che hanno aumentato la complessità della vita urbana e pongono i pianificatori di fronte a sfide importanti. In queste condizioni, è diventato necessario per la città funzionare come un unico sistema strutturato in grado di affrontare strategicamente le principali questioni urbane, con l'obiettivo di raggiungere la sostenibilità e il massimo benessere sociale possibile. La tecnologia emerge quindi come un meccanismo che consente alle città di affrontare queste sfide in modo più efficace. Le trasformazioni tecnologiche hanno portato numerosi vantaggi, segnando un passaggio dai metodi di pianificazione tradizionali ad approcci innovativi basati sulle funzionalità offerte dalla tecnologia, in particolare dall'intelligenza artificiale (IA) e machine learning (ML). In questo senso, l'IA e il ML non dovrebbero essere considerati solo come strumenti tecnici, ma anche come strumenti essenziali per il funzionamento efficace delle strutture sociali, economiche e politiche della città.

In questo contesto, la presente ricerca propone un sistema di comunicazione con i cittadini basato sull'elaborazione del linguaggio naturale (NLP) con l'obiettivo di coinvolgerli nel processo di pianificazione. La raccolta dei dati avviene tramite una pipeline dedicata, che parte dai social media e dai questionari, elaborandoli nella lingua madre. La mancanza di librerie specifiche per la lingua albanese ha imposto la costruzione di un nuovo sistema, che offra una riflessione più realistica del sentimento espresso dai cittadini e dimostri il potenziale della tecnologia nel colmare le lacune strutturali nei dati. Inoltre, questo studio analizza due problematiche urbane attraverso l'applicazione di tecniche di ML e IA. I risultati sono stati valutati sia dal punto di vista dei cittadini che di quello degli esperti, evidenziando i vantaggi degli approcci basati sui dati alla pianificazione urbana. Inoltre, il modello di comunicazione sviluppato introduce un nuovo approccio strutturato che collega i modelli teorici di pianificazione partecipativa con la loro applicazione pratica, basandosi sui bisogni e sulle richieste della comunità.

Parole chiave: pianificazione partecipativa, intelligenza artificiale, machine learning, NLP, città intelligente, sostenibilità

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Abbreviations

AI – Artificial Intelligence

AR – Augmented Reality

BoW – Bag of Words

BSI – British Standards Institute

CAD – Computer-Aided Design

CNN – Convolutional Neural Networks

DL – Deep Learning

DT – Decision Tree

ESDN – European Sustainable Development Network

FAO – Food and Agriculture Organization

GEF – Global Environment Facility

GDPR – General Data Protection Regulation

IAP2 – International Association for Public Participation

ICT – Information and Communication Technology

IDF – Inverse Document Frequency

IoT – Internet of Things

ITU – International Telecommunication Union

LR – Logistic Regression

ML – Machine Learning

MLP – Multilayer Perceptron

NB – Naïve Bayes

NSDS – National Sustainable Development Strategy

OECD – Organization for Economic Co-operation and Development

PCA – Principal Component Analysis

PLIS – Planning Information Systems

RF – Random Forest

RNN – Recurrent Neural Network

SMOTE - Synthetic Minority Over-sampling Technique

SVM – Support Vector Machines

UGC – User Generated Content

UN – United Nations

VCM – Virtual City Models

CHAPTER 1 - Introduction

People today live in a world that is more urbanized and complex than ever before. The issue of urbanization is regarded as one of the greatest global challenges, which makes transforming the management of the resulting complexity a key priority for maintaining and developing sustainable cities. Around 2050, it is expected that about 68% of the world's population will live in urban areas (United Nations, 2024). This means that the problem must be solved as soon as possible through thought-out strategies and policies to maintain economic, social, and environmental stability which are decisive for urban space management. Since the planning of urban spaces is a process and not just a physical plan, despite the great challenges facing decision-making institutions and urban planners, they must maintain and develop the necessary infrastructure to support social well-being for citizens. In this context, it is essential that the city operates as a structured system that strategically addresses all key urban issues to sustain its life cycle while pursuing objectives of long-term sustainability.

To address these challenges, cities today strive to become smart by fulfilling fundamental principles like inclusiveness; however, the interpretation of concepts such as 'smart cities' and 'participation' largely depends on the urban and institutional context. These important concepts take on a different form and explanation, especially in countries that are under development and after fast and major transitions as Albania is. The shift of the political and social regime in 1990, for the country, from communism toward democracy was accompanied by a series of radical changes that influenced also planning and management of the territory. The issues in politics, economy, and social welfare are manifested in the country's urban planning and architecture, resulting in a spontaneous urbanization process recognized as informal urbanization (Aliaj et al., 2003). The informal built environment, particularly during the initial two decades (1990-2013), produced whole new neighborhoods surrounding the major cities of Albania, concurrently fostering new communities. Meanwhile, the institutions perpetuated a longstanding pattern, established throughout the communist regime, wherein authorities made decisions for the populace without regard for their needs, thereby excluding them from the decision-making processes. This non-inclusive planning culture is critical to decision-making today, despite legislative frameworks that advocate for inclusivity. Precisely this aspect of urban planning, the involvement of the members of the society in the process, constitutes the central focus of this study, which takes the city of Tirana as its case study.

In official documents it is shown that the drafting and approval of an urban plan project in Albania, follows a standard path well-defined in regulations. But what is noticeable in those processes is the fact that citizen participation is 'lost' through rigid, bureaucratic procedures such as public hearings, public exhibitions and roundtable consultations without any concrete results.

Technology offers extraordinary potential in overcoming the above-mentioned challenges. By analyzing the staggering amount of data produced daily by digital devices and online platforms, such as social media, using ML and AI techniques, it becomes possible to read, interpret, and predict valuable insights in real time. It's important to note that these technological advances have greatly changed how planners work with traditional planning methods, but even with many technological tools available, the case of Tirana, Albania, shows that getting citizens involved in these processes is a critical issue. Consequently, fostering a collaborative culture in the urban planning process must be regarded as a paramount concern in order to safeguard a fundamental right for citizens—the unrestricted expression of their views on policies that directly impact them.

1.1 Background and problem statement

Digital transformation has globally impacted every aspect of people's life. Massive data processing is no longer seen as an issue, but many units still struggle to adapt to the ever-changing environment brought about by innovations in technology or are hesitant to adapt how they operate. Urban planning is a discipline confronting significant issues that result from increased urbanization. Among the various domains that urban planning must address, including the environment, economy, and infrastructure, the social dimension is the most complex and challenging.

Among several societal considerations, cultivating a collective feeling of responsibility for the advancement of smart cities, accompanied by a clear vision for future generations, is seen a fundamental principle of long-term sustainability. Technology provides several benefits, including the use of AI techniques to analyze data, support social well-being in cities, reduce environmental impact and create spaces that are suitable for future challenges. Its integration into the urban planning processes significantly facilitates decision-making both by public authorities and urban planners. The involvement of citizens in this process is considered a fundamental democratic principle, associated with transparency and equality. To prevent the process from being perceived exclusively as a top-down approach centered on technical jargon it is essential to consider including the citizens' opinions as vital for effective implementation urban plans and/or policies.

The concept of participatory planning is globally considered key to achieving long-term sustainability objectives for smart cities. Nonetheless, its execution represents different challenges difficulties in developing and post-transition countries. Tirana, the capital of Albania, exemplifies a significant instance of swift political, economic, and social development since the early 1990s. The transition period was characterized by institutional and governmental instability, uncontrolled urban expansion, and extensive rural-to-urban migration, leading to fragmented and frequently informal urban development. The city has long been deprived of a cohesive and consistent urban planning framework.

The situation has been improving annually; Tirana has had significant development, especially in its physical structures. The construction wave continues, accompanied by additional needs that must be considered, such as the requirement for green spaces, entertainment spaces and service facilities. It is evident that there has not been much improvement in citizen participation in the urban planning processes of the area they live in. Consequently, the lack of comprehensive urban planning model and transparency in decision-making processes, have fostered a culture of non-cooperation and, primarily distrust in the public authorities. Citizens have lost their sense of belonging to the city, while institutions passively stick to conventional procedural approaches that cannot be considered participatory at all. This model triggered a chain reaction that has led to various effects within the urban environment. The problem lies not merely the failure of existing techniques to secure participation, but rather the absence of a vision for developing a sustainable, citizen-focused city.

To summarize, the core problem is related to the lack of a comprehensive vision in urban planning practices and the inability to build sustainable mechanisms that empower citizens' active role in decision-making processes. With the country being more economically, socially, and infrastructurally stabilized, there are more opportunities for policies and concrete actions to encourage genuine citizens' participation in the planning process. Social media, as a broad communication platform, constitute a very worthwhile opportunity for authentic interaction between citizens and institutions. Citizens spontaneously use these channels, providing valuable opportunity for data-driven decision-making. By promoting a more transparent process, these instruments significantly enhance the legitimacy of urban initiatives and policies. Therefore, this research introduces a distinct methodological approach to participatory planning that is based on this instrument.

1.2 Aims and objectives

The main aim of this research is to develop a participatory planning model based on social media that enables data-driven urban planning decisions. By combining citizen and expert perception in a natural language processing (NLP) – based system, the research demonstrates how sophisticated ML and NLP techniques can overcome the limitations associated with resource-constrained languages such as Albanian. To achieve the main goal of this research, the objectives are:

- To examine the role of social media as communication channel between citizens, experts and institutions in enhancing citizen participation in decision-making processes by developing a comprehensive data-driven planning model.
- To assess how the perceptions of both citizens and experts can influence and enhance the acceptability and legitimacy of urban projects and plans, particularly in contexts where participation is merely symbolic.
- To explore the potential of sophisticated AI techniques to enable deep data analysis in resource-constrained language contexts.
- To develop a dedicated system for data preprocessing in the Albanian language by combining JavaScript methods with AI techniques, including the design of a mini-system for the detailed evaluation of citizens' and experts' comments.
- To implement and optimize a set of algorithms for generating predictive models and insightful analyses, and to transform these analytical results into evidence-based recommendations that can contribute to decision-making processes.
- Finally, to assess the applicability of the proposed framework in the urban context of Tirana as a valid case study for cities with similar urban dynamics.

1.3 Research questions

The main question this research aims to address is: How can participatory planning be achieved through a data-driven paradigm based on social media networks?

This central question is further explored by addressing the following subsidiary questions:

- How do citizens and experts perceive participation and the urban planning process in Albania?
- How can social media platforms serve to collect data from citizens and experts on various urban planning issues and projects?
- How can ML and AI techniques contribute to participatory decision-making in a resource-constrained language such as Albanian?

1.4 Research methodology

Based on the purpose of this research, the proposed methodology includes a series of phases that aim to develop a participatory planning model based on social networks. This research focuses on the analysis of data collected from citizens and experts about an urban project such as Tirana Riverside, which serves as the main case study. To avoid the problems of unstructured data and the diverse lexicon of social networks, which would make data preprocessing and analysis practically impossible without semantic understanding of words since the NLP libraries for preprocessing in the Albanian language are missing, a more controlled approach to data collection was adopted through the use of questionnaires. Two questionnaires have been designed at different levels of detail to address the distinct perspectives of citizens and experts. The questionnaire itself performed various backend functions by using additional JavaScript code, which helped eliminate the need for manual work on data preprocessing. This is a critical phase of the entire methodology, in which lies the difference in the application, as a series of mechanisms created specifically for this research have been used to overcome the lack of libraries for preprocessing data in the Albanian language. This entire mechanism is considered an NLP system, as it is designed to make data understandable for ML algorithms and ready for deep processing. Further work focuses on advanced data processing using ML algorithms and AI techniques to build predictive models with reliable parameters. Ultimately, a series of descriptive and predictive analyses have been carried out for both citizens' and experts' perspectives, accompanied by graphs and ML performance indicators. By bridging citizen voices with experts' insights, the proposed framework can provide real recommendations for inclusive planning practices.

1.5 Limitations

Given that the proposed methodology has not previously been tested in the Albanian context, this thesis is subject to several limitations. One of the primary limitations stems from the absence of specialized NLP libraries for data processing in the Albanian language. Data processing was conducted in the citizens' native language, as the native language represents the most authentic way of expressing perceptions and emotions, thus providing a more realistic reflection of sentiment. However, under these conditions, several ML techniques are constrained, bringing certain limitations in data preprocessing and analytical depth.

A further limitation is related to the use of social networks as the main source of data. This instrument, while offering various benefits for collecting real data from citizens due to its widespread use and spontaneous nature as a communication channel, also raises concerns about data integrity and potential bias.

The small number of expert responses (60-70) is another significant limitation of the research. The limited sample size prevented many potentially valuable analyses from being conducted, as their results would not be considered accurate due to the lack of a sufficient statistical basis. As a result, the scope of analyses based on the opinions of experts remains restricted.

Alongside, this research is situated in the context of Tirana, where the participatory planning process is characterized by limited democratization. While this context may be considered a potential limitation, it also represents a relevant testing ground for the proposed approach, as it reflects environments in which citizens' opinions are frequently undervalued — a condition commonly observed in many developing and transitional urban contexts.

In light of the above considerations, it is also important to acknowledge that cooperation with institutions has been relatively limited, which constitutes a further limitation of this research. Rather than reflecting a lack of institutional interest, this fact may be associated with the challenging political and legal context experienced recently in Albania; therefore, assessing how the proposed framework could be adopted into an institutional approach remains to be tested in the future once the institutions have overcome these difficulties.

1.6 Thesis organization

The chapters in this research are structured in the following form:

Chapter 2 presents the theoretical and conceptual framework of the topic. The chapter opens with the basic concept on which this research focuses: participation in urban planning. The evolution of participation in urban planning has been studied based on different implementation models, which are discussed under the term of planning paradigms, to create a more complete understanding of this concept and to establish a foundation for further empirical work. To provide a full interpretation of this approach, the chapter also discusses the challenges and criticisms associated with the concept of top-down planning. In addition, the chapter provides a detailed analysis of two concrete cases of successful implementation of top-down planning in two developed-world cities, Singapore and Copenhagen. Finally, the issue of smart cities was addressed as participatory environments to create a bridge between participation and technology, which is discussed in the following chapter.

Chapter 3 presents the shift in urban planning and participation due to technological developments and AI. Given that the research is based on data collected from social networks, this chapter further explores the advantages and challenges related to its use in improving urban planning practices towards real participation, illustrated through some illustrative cases. After conceptually addressing these aspects, the chapter establishes a link to the urban context in Tirana. To have a clear picture of the problem on which the study is based, the section explores the evolution of the urban planning process in Tirana after the 1990s. In this analytical framework, the case of Co-PLAN has also been treated as an illustration of participatory practices in urban planning developed over the years in Albania. The current process of approving urban development projects is further addressed, with the aim of creating a clear framework of institutional and practical reality.

Chapter 4 deals with the technical concepts of the practical work carried out within the framework of this research. Initially, the chapter presents the basic functionalities of ML, serving as a theoretical basis for a more detailed analysis of the algorithms. Since the empirical work of this research focuses on the classification of ML text data, the algorithms described belong mainly to this category. Beyond traditional ML approaches, the chapter provides an overview of DL algorithms, emphasizing their role in improving model performance. Then, the chapter also devotes a special section to NLP, which is essential for processing textual data. The chapter concludes with a general presentation of the methodological framework proposed in this research, establishing a logical transition to the subsequent chapter, which details the concrete implementation of the model.

Chapter 5 provides a detailed description of the empirical work conducted as part of this research. The chapter begins with a critical overview of the current situation of participation in urban planning in Tirana, followed by a description of the selected case studies and their relevance to this research. Further, the concrete ML steps followed in the NLP system created specifically for the purposes of this research, in the absence of relevant libraries for the Albanian language, are explained. Finally, in this chapter, all the tested algorithms, the work done for their optimization and the results achieved through ML metrics are discussed.

Chapter 6 concludes the empirical work of this research by presenting the results of the analyses conducted and offering recommendations on participatory planning strategies. The proposed findings are directly grounded in the results of Chapter Five, thereby ensuring a coherent logical continuity between the methodological framework, the case studies, and the final outcomes of the research. This chapter ends with a precise overview of all these conclusions by emphasizing their significance in the field of participatory planning.

Chapter 7 presents the final conclusions of this research by synthesizing the empirical findings with the theoretical framework for participatory planning discussed in the previous chapters. It also evaluates the effectiveness of the proposed methodological model used to address the research questions raised. In addition, this chapter provides recommendations from the perspective of urban planning on the integration of social media, ML and AI into urban planning processes. Furthermore, the chapter highlights the main contributions of the research and concludes with recommendations for possible future research in this field.

CHAPTER 2 - Theoretical and conceptual framework

"Cities have the capability of providing something for everybody, only because, and only when, they are created by everybody." (Jacobs, 1992)

This expression summarizes the basic premise of this chapter: citizens' involvement in urban planning and other aspects of decision-making is a fundamental process for developing sustainable cities. To understand this relationship, it is necessary to first create a clear picture of participation, the forms of citizen participation, the principles that guide its implementation and how this concept has evolved over time. In this context, the chapter addresses precisely these theoretical dimensions by analyzing the conceptual foundations of participatory planning, the planning paradigms, and criticisms of them, as well as the challenges associated with the implementation of smart city practices.

2.1 Citizen-driven participatory planning

Planning is an essential part of national growth. In numerous cities, urban planning is predicated on the development of theoretical policies, aided by experts who devise approaches that do not adequately address the real requirements or issues of communities as a whole. The notion of participation in urban planning is profoundly embedded in human history, as its defining principles —solidarity, unity, cooperation, and community — have consistently been essential to societal structures. These concepts have historically influenced the social and anthropological evolution of humans, forming the basis for communal organization and interaction. In this context, participatory planning represents a very important approach to urban planning processes, which should be considered an indispensable democratic mechanism that places the citizen at the center of urban and social development. This section begins with the various definitions and interpretations of the notion of 'participation' as a broad concept which has always been essential in social structures. Further, this concept is treated as a part of the principles of social sustainability, to continue with the forms of participation. Since citizen and stakeholder involvement do not represent the same approach – as they do not require the same conditions to be part of the process and do not offer the same type of input – a detailed comparison between them has been made, highlighting the advantages and necessity of their involvement in different phases and forms of urban planning.

2.1.1 The concept of participation

Participation in urban planning represents an early approach marked since the period of the decolonization movement of the 1960s, where the subsequent political autonomy of numerous nations elicited considerable enthusiasm and confidence. This era had a transformation in the development paradigm, highlighting the significance of grassroots movements and the human factor in influencing advancement. Subsequently, the need for participation was further emphasized in the 1979 "World Conference on Agrarian Reform and Rural Development" by the Food and Agriculture Organization (FAO, 1980). This movement is worth mentioning in this research because, in addition to showing the historical foundations of how citizen participation in decision-making processes began to be promoted, it also declared participation as a human right and an indispensable tool for effective urban development.

Consequently, over time, participation became increasingly significant, seen as an essential element in promoting self-determination, social empowerment, and inclusive development initiatives. Today it is viewed not just as a social norm but also as a fundamental tool for inclusive government, civic participation, and power distribution in contemporary societies. The term participation carries two distinct meanings (UNESCO, 1986). On one hand, it can refer to mere involvement, where individuals are passively subjected to a process without any real agency or influence — such as in cases of forced labor or coercion. On the other hand, participation can signify active engagement, where individuals contribute meaningfully and share responsibility in shaping and executing a process. Is the genuine and significant participation that encompasses all individuals, social groups, and nations, allowing them to influence decisions and projects that directly impact them at a local, regional, national, and international tiers.

On the other hand, participation being an essential component for urban development and social sustainability, is influenced by the underlying vision of development, which determines its character and methodology, including goal selection, planning strategies, management tactics, implementation strategies, and procedural frameworks (Nie et al., 1969). Participation is therefore intrinsically tied to the political system and the ruling class. Because of this reliance, the idea of participation is still ambiguous since it can be construed in a variety of ways based on the situation and purpose for which it is used. Two different but complimentary viewpoints — one centered on promoting change and the other on maintaining social stability — can be utilized to understand participation. The participants' societal goals and the degree of difference between their present social circumstances and the ideal future state determine the course of involvement. Participation can be an instrument for social advancement when it is focused on transformation, supporting structural changes and reforms. On the other hand, when its goal is to preserve equilibrium, it upholds preexisting social structures, guaranteeing stability and continuity within a system or community (Reicher & Haslam, 2013). The following are key definitions of this concept:

- Participation is a multifaceted and intricate process, as its legitimacy is not exclusively based on the state (Tilly, 2004).
- Participation is a complex process that can occur in various social and organizational activities, including political, cultural, educational, union, environmental, scientific, literary, and philosophical involvement (Fung, 2005).
- Participation is a comprehensive, multicultural endeavor designed to encompass all cultural and ethnic groups within society. Instead of prioritizing absorption or assimilation, it underscores equal participation, acknowledging the right to variety, innovation, and the potential for failure as integral to the participatory experience (Kymlicka, 2000).
- Participation is a complete process and a crucial feature of a national political framework, so the state must commit to its broad execution. But, as a whole process, should not be confined to political and economic goals, as is frequently observed. It must also consider social, cultural, and ethnic requirements, offering a holistic, inclusive, and equitable approach to development.
- Participation is a key development instrument that unites politics, economics, society, culture, and family life. It is widely recognized as a civic and social learning process and a human right that promotes personal fulfilment (Gaventa, 2006).

As can be inferred, this issue simultaneously generates various perspectives and discussions and constitutes a very sensitive topic, particularly today as the world faces radical economic, political, and social changes due to rapid urbanization and digital transformation.

To summarize these views, it can be said that a good part of the population consider it as a true democratization of power in which people and communities actively participate in decision-making; others criticize it as a superficial or symbolic move, contending that it frequently gives the appearance of inclusion without actually giving people any real influence over important decisions, thus strengthening rather than undermining existing power structures. This problem is observed in many countries where participatory processes have not yet been consolidated. For instance, Albania exhibits a distrustful attitude towards the inclusion policies implemented by the relevant institutions. The most important cause of distrust is the institutions' lack of transparency, but there are many other factors. Participation, when truly active, intentional, voluntary, and accountable, functions as a key instrument for the cultivation of power. In this case, since participation has not cultivated a sense of power in decision-making processes among citizens, it means that the strategies or mechanisms used have not been realistic or persistent enough to achieve the goal. Gaventa (2006) further reinforces this gap by emphasizing participation, as the way of how people and organisations determine the meaning of their acts and support larger social movements. As a result, the community's dominant value system needs to serve as the basis of involvement since it offers direction and significance, even if it changes over time.

On the other hand, participation, which is one of the basic principle of sustainability, must be organized within the framework of social institutions to provide coordination, conflict resolution, and the ongoing development of its members. This fact has become a necessity considering that development is a continuous process. This calls for evaluating the advantages and difficulties of formalizing participation as well as addressing the barriers and prerequisites for its effective execution (US EPA, 2021). Without a fixed model of citizen participation in decision-making processes, policies may not reflect the real needs of citizens, leading to resistance and non-adaptation to the changes made. This has happened in the city of Tirana, where citizens have often been confronted with public institutions for various urban projects that have been approved following hermetic procedures without consultation with residents. Thus, such situations have significantly reduced trust in the legitimacy of the processes carried out by the relevant authorities, leading to their demotivation to be active. Such a problem is further linked to a series of consequences that will be discussed in the following chapters. To put it briefly, authentic public engagement is crucial for formulating and successfully executing an internally motivated development strategy (Sen, 1999). In its absence, development policies may become unstable or be controlled by powerful and influential entities.

2.1.2 Participatory planning for sustainability

In recent decades, there has been a significant rise in urbanization globally. The increase in population in urban areas brought a series of problems in housing, public transportation, traffic congestion, infrastructure deficits, diminishing green spaces, and a weakening of urban identity – in general, a decline in the quality of life for people. This accelerated development pattern has resulted in issues that conflict with the core principles of sustainability. In considering this situation, it was essential to make a significant operational modification in the urban planning process to consider various scenarios, such as globalization, prior to the implementation of diverse policies. In 1987, the Brundtland Report "Our Common Future" emphasized the necessity of public participation in achieving sustainable development goals. Thus, throughout the 20th century, numerous urban models emerged, designed to minimize development for optimal land utilization, enhance urban infrastructure efficiency, and foster sustainable social interactions to promote citizen collaboration for collective welfare.

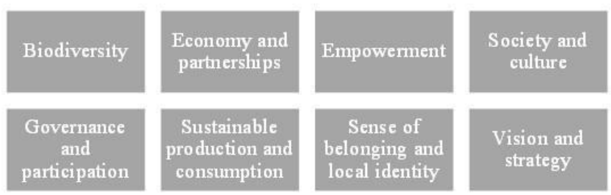
Sustainable development is widely recognized as a fundamental pillar that relies on active citizen participation in planning and decision-making, but there are many different definitions of it, that generally relate to social, economic, and environmental well-being: protecting natural resources, ensuring a secure economic level, and developing public systems that are transparent and inclusive (Robinson, 2004). In light of the above considerations and supported by the relevant literature, urban sustainability can be conceptualized through four main components: economic, environmental, social and institutional (Basar, 2024). But of these components, social sustainability is the one that has developed the slowest, because it has not received the proper attention (Woodcraft, 2012). This dimension, which focuses on social relations and communities, includes issues such as the quality of life that people lead, integration into society, social cohesion, human rights and decision-making (Haasnoot et al., 2013; Panda et al., 2016). Studies has shown that by integrating social sustainability into urban planning, cities can enhance livability, reduce environmental impact, and create spaces that are adaptable to future challenges. However to achieve this, participation should be authentic, inclusive, deliberative, and communicative, ensuring that citizens' concerns and needs are thoroughly addressed (ILG, 2021; UNU-CS, 2018).

The strategy chosen to achieve sustainable development implicitly involves the participation of the public in decision-making due to the cultural and social diversity that characterizes the society nowadays. According to Amado (2010), these planning models require a combination of components such as:

- Ethnic, cultural and social components as a highly sensitive aspect for the population
- Pluralism in public participation
- Integration of policies that preserve the identity of the community

Several studies deem the recognition of these aspects essential for the successful execution of policies and public adaptation, particularly in the future (Amado, 2005). Using creativity and aspects of many cultures together is essential in today's urban societies because they significantly affect social cohesion and also provide economic advantages (Landry & Angeles, 2011). Furthermore, studies have listed several factors that are considered very important in building comprehensive urban policies with a vision of sustainable cities. Figure 1 presents these factors.

Figure 1. Principles for sustainable planning



In addition, according to OECD (2023), by incorporating diverse views and harnessing collective knowledge, inclusive and impactful participation not only enriches the policymaking process but also strengthens public understanding of outcomes, promotes policy uptake, and reinforces trust in public institutions. Therefore, contemporary cities are going through tremendous social, environmental, and economic transformations that significantly influence urban integrity.

Neuhoff (2023) identified several forms of the future with participation:

- Planning through interdisciplinary methodologies and activities led by experts. This form integrates quantitative and qualitative models from industry, academia and experts at leading institutions. This participatory model is focused mostly on the technical aspect of the process and aims to predict the urban future accurately through the use of secured data.
- The public future can be shaped through training and social learning. Simulating social learning through experimental processes to build capacities is a model that aims to shape a future with a longer-term vision.

- Information policies based on several pillars, such as academia, state, industry and citizens. This model is focused on the degree to which the public accepts different urban scenarios and aims to improve the information policy agenda by integrating the different views of the aforementioned actors.

To conclude, by promoting extensive participation, planning initiatives can more effectively adhere to sustainability principles, ensuring that growth satisfies current need without affecting future generations' capacity to fulfil their own needs.

2.1.3 Forms of participation

Dalal-Clayton and Dent (1993) identified various forms of participation and emphasized the distinctions between consultation and participation. These forms are listed below:

1. Passive participation

   Despite its ubiquity on online social media platforms, there have been few studies conducted on passive participation. This type of involvement includes individuals being notified about decisions that have already been finalized or plans that are scheduled to occur, without any significant opportunity to contribute or affect the outcome. It is fundamentally a unilateral communication in which the government or project managers issue announcements without engaging with or acknowledging the viewpoints and concerns of the community. Consequently, the dissemination of information is regulated by experts, resulting in minimal to no participation from local individuals in the decision-making process (Pretty, 1995).
2. Participation in information gathering

   Unlike the passive form of participation, in this form citizens have the opportunity to share information and knowledge with leaders regardless of whether the final decisions are influenced by this data or not. Usually, this method is used in the diagnosis of various urban and environmental issues, etc., where people have knowledge that can help experts better understand certain situations and conditions in the local context. However, according to Pretty (1995), citizens here engage by responding to enquiries from experts or leaders who are interested. Although it is a slightly passive form of participation, it improves the process by informing the relevant authorities about the needs and demands that may arise in various urban issues. According to Cornwall (2008), this form of cooperation can serve as a preliminary step towards broader and more meaningful participation.

3. Participation by consultation

   In this form, citizens are invited to express their opinions on various proposals without certainty that their voice would be acknowledged. At this stage, decision-makers are not obliged to reflect these opinions in the decisions or policies they undertake. The tactics used to achieve this form of participation are usually public hearings, questionnaires, meetings with certain representative groups, etc. Arnstein (1969) positions consultation at a low level rung of participation, considering it as a tokenistic form which is mainly used to legitimize predetermined decisions. But if these consultation processes are well-structured, transparent, and inclusive, they offer excellent opportunities for citizens to be actively involved in the decision-making process and influence them (Bobbio, 2019).

4. Participation for material incentives

   This form of participation refers to the contribution or involvement of citizens in projects that receive material goods. This form usually occurs when people are not really interested in the implementation of the project or governance. This form of participation can be effective for quickly mobilizing citizens to participate in certain projects, but many researchers argue that when participation is motivated by external incentives, the possibility is very low that this participation will be long-term and efficient (Cornwall, 2008; White, 1996).

5. Functional participation

   In this form of participation, people are organized to perform specific tasks, such as project management, managing various services, etc., but their influence remains limited in the decision-making. According to Pretty (1995), this form is usually introduced after decisions have been made but is used as a strategic move more to increase the sustainability of projects than to actually empower citizens. This type of participation is top-down, as it is initiated and managed by governing authorities, unlike consultation.

6. Interactive participation

   This form represents one of the most transformative models of citizen participation. In this model, citizens and public institutions collaborate at each stage of the planning process through joint discussions and other inclusive activities. Numerous studies argue that interactive participation, being a real model of public inclusion, increases the legitimacy of governance, establishes a balance in the levels of power between citizens and the state, and increases civic capacity (Fung, 2006).

7. Self-mobilization

   This type of engagement is the highest and most autonomous form of civic participation: citizens and communities, independently of institutions, organize activities to reflect their demands, needs, and priorities, usually in response to issues or policies that they may consider unjust or ineffective. This model demonstrates a sense of ownership and empowerment that is even more valuable in places where institutions do not function properly and do not represent the interests of the general public. Self-mobilization can lead to major social changes if supported by a large network, but it can also be limited if it encounters resistance from governing authorities (Hickey, 2004). Consequently, this form of participation has the potential to bring about major bottom-up transformations, it needs broad and long-term support and should also be recognized by the relevant public institutions to avoid problems.

On the other hand, the European Sustainable Development Network (ESDN) categorized the forms of participation in three groups, as presented below (ESDN, 2007):

a) Ad hoc forms

Ad hoc participation is short-term, issue-driven engagement in response to a need or crisis. Informal, flexible, and spontaneous engagement allows people and groups to act quickly on critical issues. Typical instances are public hearings on specific policies, local petitions, citizen demonstrations, or temporary advisory bodies set up to handle pressing issues. While ad hoc involvement can be quite effective in increasing awareness and influencing decision-makers, its long-term influence is usually restricted unless it is supported by more institutionalized and organized systems. As underlined in OECD's Guidelines for Citizen Participation Processes (OECD, 2022), these participatory approaches are absolutely essential for democratic participation, particularly in cases of public involvement in decision-making that is urgently needed. Ad hoc groups in the framework of global governance are independent agreements with a task-specific obligation created at short notice for a limited duration. These alliances develop to solve certain problems and disintegrate once their goals are reached (Reykers et al., 2023). In organizational contexts, these committees function as temporary groups established to address particular issues within a company or institution, usually constituted by senior executives or governing boards and comprise of experts in the topic at issue. Although ad hoc involvement lets one respond quickly and deliberately to pressing issues, its temporary character means that more permanent, institutionalized forms of engagement usually complement it for sustained impact.

b) Institutionalized forms

Institutionalized public participation is established through structured processes within governmental frameworks that guarantee ongoing citizen input in policy-making. These standardized procedures encourage accountability and openness by involving the public in decision-making. Community budgeting is a significant example, in which residents directly allocate public resources, thereby enhancing their sense of ownership and guaranteeing that the budget choices represent the interests of the community. Many towns throughout the world have adopted this strategy, which has led to more effective and responsive governance (Landry & Angeles, 2011). The establishment of citizen advisory committees, which function as structured platforms for community members to offer their perspectives on a range of policy issues, is an additional instance. These boards contribute to the inclusion of diverse viewpoints, which makes policy decisions more inclusive and balanced. According to studies, incorporating such institutionalized engagement improves the delivery of public goods by customizing them to each citizen's unique demands, which eventually strengthens social connection (Bobbio, 2019). Despite its benefits, institutionalized participation presents challenges. The development and sustenance of effective participatory frameworks require substantial effort, funding, and interpersonal skills. Additionally, there is a risk that participation may become superficial if not fully integrated into decision-making processes. Tackling these challenges necessitates a dedicated commitment to fostering an inclusive culture of engagement and ensuring that participatory methods are readily available, influential, and genuinely crucial for all residents (Menon & Hartz-Karp, 2019). In simple terms, institutionalized forms of participation provide an opportunity to more democratic and responsive governance; however, their success is contingent upon a real commitment to valuing citizen input in the policy-making process, appropriate funding, and methodical design.

c) Hybrid forms

To overcome the limitations of traditional urban planning, the design process should adopt flexible, evolving, and innovative planning approaches that can adapt to changing needs and circumstances (UN-Habitat, 2011). In order to improve inclusivity and efficacy in decision-making procedures hybrid forms of engagement with the public integrate digital tools with conventional in-person interaction techniques. This strategy aims to reach a wider audience and enable more thorough public involvement by utilizing the advantages of both in-person and virtual encounters. Both traditional participation methods, such as in-person meetings with authorities, and technological approaches, like digital platforms, play a crucial role in planning processes that effectively engage the public. Selecting the right method involves evaluating its effectiveness, efficiency, and ability to ensure equitable public involvement. Zhang's study (2023) looks into the idea of "hybrid deliberation," which combines in-person and online forums to encourage conversations between citizens. The study shows that these mixed models can help with problems that come up with using only old or digital ways to participate, like making them harder to use or less likely to get people involved. Hybrid consensus can improve the quality and openness of discussion in society by combining these methods. In scientific research, hybrid participation approaches have been used specifically to involve the public in both data gathering and analysis. The Citizen Social Lab platform serves as a case study of this, enabling research on human behavior through the integration of digital technologies and conventional engagement techniques within a citizen science framework. In addition to expanding the scope of data gathering initiatives, this strategy enables people to actively participate in scientific research, increasing the inclusivity and impact of involvement (Vicens et al., 2018). Another hybrid strategy is the incorporation of mobile applications into public involvement. According to a study looking at mobile apps for tourists visiting heritage sites, these resources provide fun and interactive opportunities for people in general to get involved in cultural preservation. These apps improve user engagement and aid the preservation of cultural heritage by fusing digital interactions with on-site encounters (Navarro & Renaud, 2022). Additionally, community involvement is changing as a result of the rise of hybrid open forums, which combine virtual and physical meeting techniques. By providing accommodations for those who might encounter obstacles to physically attending, these gatherings seek to increase the equity of public sessions. Hybrid meetings can boost public involvement and guarantee that different viewpoints are taken into account during the decision-making process by offering several channels for participation (PublicInput, 2021).

2.1.4 Stakeholder vs citizen participation

For the involvement of citizens in public decision-making, there are different terms, such as citizen engagement, civic participation, public participation, etc. It is very important to distinguish between the involvement of interested parties in this process and the involvement of citizens because the strategy of their involvement should not be treated the same. The OECD report (2022) presents the following definitions:

- Stakeholders are considered parties interested in or affected by the policies undertaken, such as institutions and various organizations that may be state or not, academia, the private sector, etc. This term originated in business management scholarship and was defined as a group or individual who can or is affected by the achievement of an organization's objectives. The concept tends to describe organized interests and different types of organizations or groups (Kahane et al., 2013). Groups can vary in their structure, the level of formality used, decision-making procedures, membership rules, interests, etc. Groups can also be non-profit and voluntary, completely detached from politics, selected to represent a section of the interested parties, etc.
- Citizens are considered individuals of a community or a country without distinction of age, gender, religion, etc. The term citizen is often used to describe the legal status of an individual, meaning that they are legally recognized as part of a state or nation. This definition of the word citizen is more related to identity and civic education than to the formal process of granting the legal status of citizenship (Kahane et al., 2013).

According to an OECD report (2017), the involvement of these two 'actors' has to do with all the ways or paths in which interested parties, including citizens, can be part of the policy-making cycle. This concept refers to the efforts that public authorities make to take into account the voice of citizens and affected parties. This report distinguishes three levels of participation for stakeholders and citizens.

- Information: This level of participation is characterized by one-sided communication, where the relevant institutions simply inform the public about the decisions made.

- Consultation: At this level, participation progresses through two-way communication, allowing individuals and stakeholders to express their opinions about the plans of the governing institutions.
- Engagement: the public and stakeholders are considered vital to the success of the policies being undertaken, and they are involved through various collaborative activities.

As previously mentioned, it is not the same approach as involving stakeholders as citizens because both of these parties do not require the same conditions to participate and do not provide the same type of input. There is no fixed way to divide which participation is most necessary, as they are often confused with each other, and yet these groups have the power to improve the decision-making process and various policies and services provided to the public. However, before establishing the strategy or path they will follow to have a collaborative and efficient decision-making process, governing institutions must decide which group they will include at which stage and set their expectations in this process depending on the category of participants. Differences between involving citizens and stakeholders are presented in Table 1.

Table 1. Citizens vs. stakeholder involvement

Involving citizens	Involving stakeholders
Public opinion perspective	Stakeholders' perspective
Diversity of viewpoints, often including viewpoints that have not been taken into account or have been neglected but may be important	Brings knowledge and expert opinions with valuable studies and evidence
Helps raise awareness and facilitates public learning about an issue	Helps to identify potential impacts and ensure their effectiveness
Facilitates building social cohesion and a greater sense of community	Depending on the type of stakeholder, can help mobilize support and resources needed to implement a policy
Threshold to participate is high	Threshold to participate is low
The participation procedure should account for the lack of time and resources for learning and participating.	Allocate specific time and resources to acquire knowledge about the subject and engage in participation.

2.1.5 Advantages and complexities of stakeholder involvement in planning

Kahane (2013) listed some reasons why stakeholders should be involved in planning, as below:

- Since these actors represent a range of interests, identities and institutional perspectives, as organized groups they have the potential to bridge the social and political diversity that characterizes a community (Curșeu & Schruijer, 2017). These groups bring together different interests and parties, bringing new nuances and perspectives that reflect the complexity of the new way of decision-making. Stakeholder participation eventually complements broad citizen involvement by providing the technical side through systematic involvement in decision-making processes (Vitálišová et al., 2021).

- Stakeholder groups provide a public forum readable by the entire public because they serve as intermediaries between the state and various segments of society. Often, governing institutions connect the interests and perspectives of the people with the groups organized for them, and the transparency of this process can be read by the groups participating in specific issues (Bäckstrand, 2006). For instance, to assess whether the environmental aspect was primarily considered in a decision, the public can look at whether organized groups that are related to environmental protection issues participated in this process (Newig, 2009). Many citizens prefer to be represented by groups they belong to rather than directly participating in politics. Thus, stakeholder groups, by their structured and formal nature, represent public interests around issues or various decisions, increasing the legitimacy of participatory processes.
- Groups created by interested parties can represent different interests and perspectives more effectively than citizens (Reed et al., 2009). This phenomenon can be attributed to various factors, including:
  - Structured groups possess a deeper understanding of the challenges they face, owing to their better-organized capacity, access to institutional knowledge, technical expertise, and a network that allows for flexibility in consultations and training. As a result, these groups find it easier to address complex issues, propose different ideas, and stay connected in the process for a longer period of time than ordinary citizens, who must maintain all of these components individually.
  - The knowledge and experience that members of stakeholder groups have, allow them to intervene at important points or moments in the decision-making process. Furthermore, familiarity with legal and institutional procedures allows them to position themselves strategically and keep their proposals within predetermined norms, increasing the possibility that their voices will be considered.
  - Knowing the history of policies undertaken and the ways in which the entire process has functioned in different circumstances gives such groups an advantage in being able to

identify patterns of success or failure in advance, avoiding ineffective strategies (Macdonald, 2008).

- All this analytical knowledge and experience gives stakeholders the opportunity to look critically at inclusion in decision-making processes, positioning themselves better and effectively impacting proposed initiatives and plans. This view of inclusion is vital for marginalized groups who can feel represented by these structured groups that usually have experience and knowledge in these processes that are so important for the quality of life of citizens (Fung, 2006).

o Stakeholders can have influence in a wider political sphere than citizens. Therefore, in the droughting of participatory strategies by the relevant institutions, it is important to take into account the ability of different parties to effectively impact different decisions. According to Elstub (2010), undertaking successful incentives and arguing through valid facts or proposals is a strong basis that supports the participation of this interested party. The involvement of such groups in the process is a factor that increases the legitimacy of decisions and ensures that the policy undertaken is in line with the interests of many parties (McKinney & Kemmis, 2011).

Despite stakeholder participation offering several advantages, such as promoting more inclusive and democratic decision-making, it has its limitations and risks. Although stakeholders usually function as organized groups with high capacities, they may not represent the opinions and concerns of the entire population, leading to the marginalization of different segments of society (Pak et al., 2017). Selecting the stakeholder groups most impacted by various decisions is challenging, potentially resulting in the exclusion of significant groups. Additionally, powerful stakeholder groups with more resources or connections might dominate the process, making it unfair and weakening the democratic nature of decision-making. Also, stakeholders may prioritize their interests as a group or organization, leaving behind real, fair interactions (Pek et al., 2022). In this situation, these strategies might reduce the benefits of the participatory decision-making process because how well stakeholders participate depends on both the people involved and how the cooperation strategies are set up in relation to their goals.

2.1.6 The importance of citizen participation in urban planning

Citizen involvement in urban planning and other aspects of decision-making is recognized as a fundamental process for creating sustainable cities. It is critical that planning incorporates a holistic approach into its strategies instead of considering this process only from a technical perspective, such as a top-down approach. Taking into account people's opinions on projects and various issues that affect them directly or indirectly creates very valuable knowledge for decision-making institutions and facilitates more sensitive decision-making. Citizens' opinions highlight many new perspectives that can be essential for the well-being of the community but that are often neglected from a technical perspective. These contributions of broad participation not only help in creating a clear picture of the local context, but also ensure that the initiatives undertaken are appropriate to meet the needs and demands of citizens. Listed below are some of the key reasons why citizens should be involved in certain stages of decision-making about the city they live in.

- Increase of public legitimacy

  Citizen engagement ensures that planning procedures integrate phases of activities or initiatives that are receptive to the suggestions and opinions of those most impacted by the implemented policies. This involvement ensures one of the principles of democracy, such as transparency and equality, in creating opportunities for citizens to freely express their opinions and demands. Consideration of their voice motivates citizens, reinforcing their role as active and efficient city participants. Furthermore, this participation cultivates social responsibility and increases transparency and political legitimacy (Sondou et al., 2025). In conclusion, citizen involvement in the planning process is one of the key points of democracy; it strengthens and revitalizes the relationship between leaders and citizens with the common goal of sustainability and well-being through a better understanding of shared opportunities and challenges (Nilsson et al., 2021).

- Inclusion and diversity

  Citizen participation in planning and decision-making makes this process more representative of the wider public. Through these inclusive processes, governing institutions can incorporate in their work the opinions of many people, including that part of the population that has often been excluded from public hearings and workshops organized for various reasons (OECD, 2022). Furthermore, this inclusiveness allows the integration of different points of view and experiences, especially those of marginalized or previously under-represented groups, in political discussions and urban design (Pek et al., 2022). Consequently, this way of working creates more useful services and policies and promotes social cohesion. In short, involving citizens and the population's diversity in this process ensures that cities are not only built for people but built with the people who live in them.

- Better policies, projects and services

  When governing authorities engage citizens in decision-making, they leverage the public's knowledge and experiences to comprehend the local context, thereby enhancing policies and devising more effective plans and initiatives for the community. This bootstrap input allows the projects developed to be more context-sensitive and more adapted to reality, thus increasing the opportunity for citizens to support and assist in the successful implementation of public projects and initiatives (Roberts, 2004; Rowe & Frewer, 2000).

- Legitimacy and facilitation in implementation

  Involving citizens in decision-making encourages them to better understand the results, which increases the acceptability of these decisions (Fung, 2006). This process allows citizens to understand, influence, and follow it until the final decision, increasing the legitimacy of even the most difficult decisions for the public because the transparency shown encourages mutual trust. Participating in the early stages of policy creation helps officials understand the root causes of public opposition and misconceptions, which are frequently brought on by misinformation. This proactive strategy prevents potential issues that could complicate later stages of the process by enabling efficient clarification and communication with the public (Newig, 2009). To sum up, participatory processes promote public inclusion and serve as tactical tools for long-term institutional viability.

- It is a citizen right

  Civic participation is a right embedded in the principles of democracy and international legal framework that recognizes the right of people to have a say in decisions that affect their lives (OECD, 2020). It may refer to particular forms of participation, like referendums, or it may be a right to particular kinds of decisions, like those pertaining to the environment, urban planning, etc. This right to inclusivity in planning and governance procedures was emphasized in the UN Habitat's New Urban Agenda in 2017 (UN-Habitat, 2017). Viewing participation in these processes as a citizen's right compels decision-makers to establish national strategies that prioritize inclusivity over mere procedural frameworks.

2.1.7 Principles for the implementation of participation

The participation of the public is an essential component of the procedures involved in the National Sustainable Development Strategy (NSDS) (Zwirner et al., 2008). It acts as a link between the various stakeholder groups and helps to maintain an adequate balance between top-down and bottom-up strategy implementation. Modern policymaking requires open engagement for multi-stakeholder and cross-sectoral collaborations. These systems ensure various views are considered and meaningfully address complicated sustainable development issues. The reality of the real world, on the other hand, indicates that the implementation of communication channels that are both meaningful and efficient among a wide variety of stakeholders continues to be a difficult task that calls for a strategy that is more structured and purposeful. Although participation is often used broadly in planning to describe various activities and processes, having a clear conceptual model is essential (Abildgaard et al., 2020). It is crucial to evaluate participation across multiple dimensions to obtain a greater understanding of the qualitative distinctions in forms of involvement. Public participation is based on many fundamental concepts that guarantee significant involvement and efficient cooperation among interested parties, and by identifying these components and representing them with practical cases, further deep knowledge of participation can be fostered. The following section will present these principles, as they were initially presented in earlier studies (Zwirner et al., 2008), and then expanded and detailed in contemporary contexts through studies and reports of recent years, such as the OECD report (2022). It is important to note that, although Figure 2 follows the structure of the OECD report guidelines, the principles are treated in an interwoven manner across studies from different years, as their conceptual foundations remain essentially the same.

Figure 2. Principles for citizen participation processes

Note. Data source: (OECD, 2022)

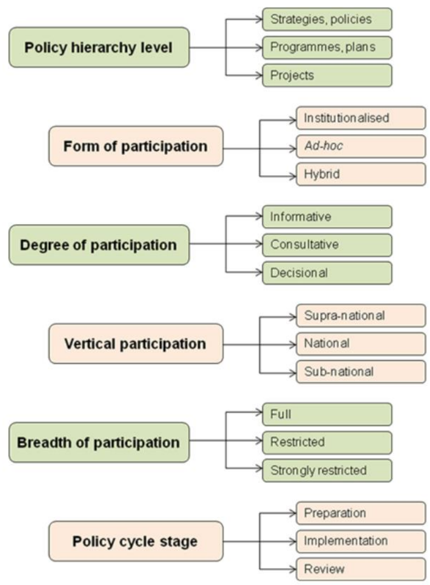
- Inclusion: Engaging individuals and representatives of society groups affected by a decision or process in the participation framework. To ensure justice and legitimacy in decision-making, this idea emphasizes different perspectives, especially those of marginalized or vulnerable communities. Public engagement becomes more representational when diverse voices are included, creating ownership and trust in the results.
- Equal partnership: Ensuring that every participant has equal rights to participate in the decision-making process, regardless of their standing, thereby acknowledging that every citizen and stakeholder representative holds valuable skills, ability, and initiative. By encouraging fairness, inclusivity, and mutual respect, this idea helps to create a cooperative atmosphere whereby every voice is heard and given equal weight. Maintaining equitable cooperation helps public involvement to be more successful, thereby allowing people and groups to actively help to shape decisions and policies affecting them.
- Expanding knowledge and perspectives: According to historic experience, local knowledge, or particular contextual awareness, every stakeholder offers special insights. Sharing these several kinds of knowledge helps all individuals to have a better and more complete awareness of the current problems. Effective policy and strategy development depends on this information flow since it guarantees that decisions are guided by both technical knowledge and practical experience. Promoting this group learning approach enhances the general relevance and quality of policy-making.
- Trust and openness: Every one of the participants helps to create an unbiased dialogue, open communication, and a collaborative atmosphere. This implies open information sharing, guarantees of clarity in the procedures of decision-making, and attentive listening to many viewpoints. Maintaining openness guarantees that all voices are heard and valued, therefore strengthening confidence in the process and motivating significant participation. The efficacy of planning resides not in its formal protocols, legal foundation, or political significance, but in the communicative practices inherent in the social ties intertwined with it (Healey, 2017).
- To guarantee informed, open, and fair involvement in the process, all participants have to have timely and equal access to pertinent information.
- Information access: A transparent and equitable participation process depends critically on each participant having equal and timely access to necessary information. Well informed

stakeholders can participate more successfully, provide insightful analysis, and make logical judgements. Clear, pertinent, easily available documentation and statistics help to build confidence, improve teamwork, and stop false information or exclusion. This idea guarantees that every opinion is respected and that decisions are grounded on a thorough awareness of the current problems, therefore strengthening the integrity of the process.

- Ownership: By including individuals and stakeholders in collaborative endeavors, among helps them grow more responsible and connected to the outcomes. People who believe their efforts are appreciated are more inclined to support and maintain choices taken during the process. In later phases, such policy execution, where success depends on dedication and teamwork, this sense of responsibility becomes increasingly vital.
- Shared responsibility: Under a participative process, every participant should have well defined roles and share equal accountability for decisions taken inside the framework of participation. This guarantees group involvement and dedication as well as encourages justice and teamwork. It is crucial to separate this shared responsibility from political responsibility, though, which in a representative democracy still rests with elected leaders who finally decide on policies.
- Empowerment and clarity: Participants should first obviously be aware of the degree of their influence and how their contributions will be applied during the decision-making process. Openness about their position builds involvement and confidence. Furthermore, persons with specialized knowledge should be urged to assume tasks related to their field of expertise so that their knowledge is properly applied to improve the general performance.
- Process design: Good involvement calls both time and good preparation. Participatory process design should take into account the length of involvement as well as the resources required of every participant—including personnel, time, and money. More inclusive and effective involvement results from a well-organized process guaranteeing that stakeholders can contribute significantly free from needless limitations.
- Integration with planning processes: Participatory procedures in a representative democracy should fit current decision-making structures to guarantee clarity on their function and impact. Including these procedures into official systems helps stakeholders to better see how their opinions support final choices, therefore improving openness, credibility, and general efficiency.

The policy process may involve the adoption of a variety of forms and implementation strategies for the aforementioned overarching principles, based on numerous factors represented in Figure 3.

Figure 3. Features and implementation of public participation in policy-making



Note. Data source : (Zwirner et al., 2008)

Successful civic engagement involves more than just political commitment from the government, supportive legislation, and the establishment of appropriate social institutions and organizations. This commitment is essential for optimal participation. Moreover, it is dependent on the fulfilment of specific obligations by the involved parties (Cornwall, 2008). Studies have shown that the efficacy of participation relies on the proficiency of the individuals involved in discourse, the thoroughness and precision of the information accessible, and the duration designated for scrutinizing each topic and its context. For that, according to Arnstein (1969), consultation procedures must be built prior to project implementation to effectively impact decision-making and the subsequent course of action during the needs identification phase. However, in order for citizens to fully participate, they must first achieve an elementary level of education and, it is necessary for individuals who are in leadership roles to participate in specialized training programs (Freire & Macedo, 2014).

As previously mentioned, participants are essential to urban development initiatives, performing a variety of responsibilities, including research, analysis, evaluation, information dissemination, meeting organization, supervision, and operations management. In order to guarantee that discussions are democratic and effective, it is imperative to maintain a continuous and productive dialogue (Evans, 2004). Nevertheless, the primary reliance on the voluntary commitment of dedicated individuals is insufficient, particularly when the objective is to broaden democratic participation across a variety of social groups. In fields such as environmental planning, it is imperative to involve experts – often in the form of counter-experts – in order to critically evaluate official proposals and present equally viable alternatives. Without appropriate compensation, it is impossible to consistently secure such specialized contributions.

2.1.8 From shared vision to practice: Some foundations for participatory urban planning

So far, the importance of citizen participation in the process of creating and developing their surrounding environment has been emphasized. One of the main goals of this approach is to raise community awareness to participate in the decision-making processes of their city, guaranteeing them a voice in planning so that the decisions made are in line with the demands and needs of citizens. But in order for their participation to be effective, it must be directed and active to ensure that the process generates more than just acceptance of the proposed project plans. Although the participatory process does not ensure immediate success, it is sufficient to minimize failures in the later stages of policy implementation or development plans. It is essential that the involvement of citizens in these processes – crucial for the city's sustainability – be seen as a source of real knowledge on local conditions, needs and attitudes of residents directly affected by the reforms undertaken. As they are regularly excluded from institutional decision-making and bureaucratic procedures, the necessity of protecting such a fundamental right of meeting their needs and protecting their interests cannot be emphasized enough.

a) Clarity of objectives as a foundation for participatory urban planning

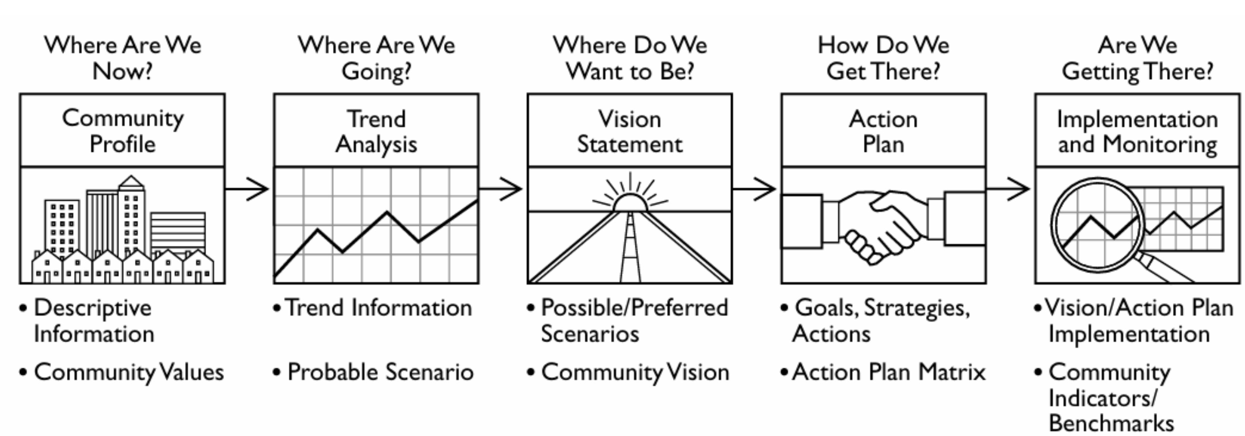
It is understandable that the goals of participation are different in different issues and times. Therefore, the program or strategy designed for citizen involvement should be well-structured, with clear objectives, and case-specific. For instance, the objectives may be of the type: resolving certain 'conflicts', generating innovative ideas, informing, identifying attitudes, etc. Above all, it is important to understand that user satisfaction does not only depend on the level at which their needs have been met, but also on the decision-making process itself, how much impact the citizens ended up having on the decision, etc. Numerous studies have listed the steps that a participatory program should follow, but in reality, there is no fixed flow for how the process should be organized. However, after determining the basic objectives, key steps to consider include identifying the stages of the planning process where citizens should be involved, recognizing the most interested groups that can play a significant role, and selecting appropriate methods or strategies for effective interaction.

b) Community visioning for the future

Developing a vision for the community involves innovative approaches to planning over an extended time period. Through this vision, citizens find it easier to collaborate and be more active in participation, because it affords them a sense of control over the future of their city. This approach allows for a comprehensive understanding of the community by incorporating its challenges and problems, as well as the issues that shape it, while also reflecting the aspirations and ideals held by its members. This much-needed process does not only focus on the current state of the city and community, but also assesses trends that may affect the future, playing a predictive role to assist in the decision-making process. The community's creation of a clear vision for the future is important, because it leads to the development of a future-oriented 'map' or 'roadmap'.

Therefore, the principle of shared responsibility must be promoted strategically to be integrated into the younger generations, including children. In this way, citizens are motivated to explore and express innovative ideas from an early age, generating a result with objective and strategic steps. One of the most famous models of this concept is the Oregon model, illustrated in Figure 4, which is based on some seemingly simple questions (Steiner & Butler, 2007).

Figure 4. Oregon model for community visioning



Note. Data source: (Steiner & Butler, 2007)

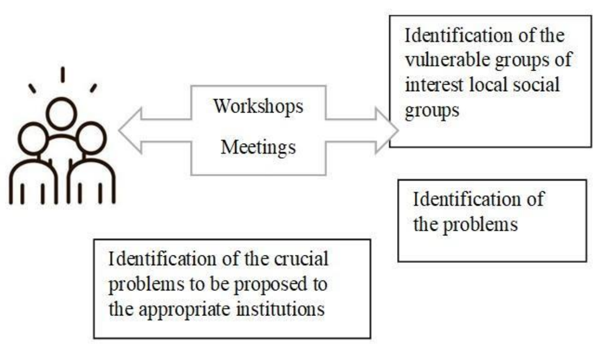
This is a model that can be adapted to any context, but it must be viewed critically to find the optimal answers to the questions it poses. In order for such a map to function for the creation of a common vision for the city's future, citizens must initially have the interest and motivation to be part of the process. Secondly, relevant institutions and organizations must support the process. In short, all interested parties must move in the same direction, with the aim of being able to form a successful long-term plan for sustainability and well-being.

2.2 Evolution of participation models

The evolution of participation in urban planning has come gradually, bringing important changes in the way of governance and city planning practices. For this reason in 1965, the idea of advocacy and plural planning was thrown as a key for improving the planning practice, both in terms of better informing the public and for compelling public agencies to compete with other groups, driving improvements in quality and efficiency. Through this idea, Davidoff (1965) emphasized the necessity of establishing an effective urban democracy, wherein residents can actively engage in the development of public policy. In this line, numerous authors from these years criticized the traditional planning model, considering it hierarchical due to its top-down approach. According to Smith (1973), legitimacy in planning can also come from citizens' active involvement because this integration strengthens each citizen's identity and responsibility to contribute to the common good. Thus it was advocated for systemic change, decentralization, community-based governance, human-centered development, and ecological sustainability over elitist and rigid conventional planning (Grabow, 1973). Decision-making institutions began to view planning processes more broadly, moving beyond their previous focus on technical and legal aspects. They began to be considered a mutual learning process between planners and the community, making them more responsive to real-world requirements. Friedman (1973) called this approach transactive planning. Many studies of these years, contended that direct citizen engagement improves problem-solving by explicitly recognizing and addressing community interests.

Further, participation was identified as one of the main pillars for sustainable development at the 'Rio Earth Summit' in 1992 by emphasizing that if there is no efficient and genuine public involvement in the development of national plans, initiatives undertaken to increase sustainability may end up useless. At this conference, a document called Agenda 21 was adopted, which was a well-structured plan for sustainable development on a global scale (United Nations, 1992). Thus, this plan was used by many countries as a basis for urban strategies, as an instrument to democratize decision-making processes, etc., and furthermore, through it, the institutionalization of this very important concept became possible. Based on the different economic, political, and social contexts, this agenda was further conceptualized in the Local Agenda 21 (United Nations, 1992, Chapter 28). Local Agenda 21 did not constitute a document with standards and action plans but the process of implementing the objectives set out in Agenda 21, emphasizing the importance of adapting it according to local needs and context, a process which was the responsibility of each country's government. For instance, participatory planning was analyzed and later implemented in several rural counties across America between 1990 and 1997, providing valuable insights into community engagement and its impact on local decision-making processes. The chosen study areas had distinct historical challenges, and the initial step involved developing a comprehensive overview of planning practices implemented over the years. In 1999 the Participatory Planning Processes (PPPs) was implemented across various San Fernando areas, intended to evaluate vulnerable populations, prioritize their requirements, and formulate appropriate actions, initiatives and a community plan (Schusterman et al., 2002). The methodology consisted of various stages such as: identifying vulnerable groups of interest through local social groups, identifying challenges, designing solutions and outlining a project, and lastly emphasizing key projects to be proposed to the appropriate institutions. These steps could be visually represented as in Figure 5.

Figure 5. PPPs methodology workflow (San Fernando)



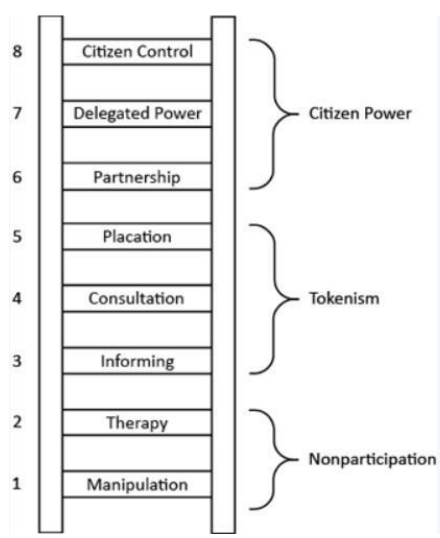
The PPPs provided a chance for community organizations to establish their priorities and to devise initiatives to meet them, and concluded that intermediate meetings comprised the most beneficial activity for the entire process.

Within the framework of the evolution of participatory planning, some of the earliest models have been selected for discussion, which marked an important turning point in the way urban planning functioned. The analysis begins with the Arnstein model; although it is a model from 1969, it is still considered an important model to determine the level of participation in different contexts. Then the ‘CLEAR’ and ‘Power Cube’ models developed mainly after the 2000s are discussed. After 2010, participation has been significantly influenced by the digital transformation, which brought a completely new and innovative approach to it. The following sections address how this approach has evolved up to the present day and serve as a foundation for the discussion in the subsequent chapter, including the analysis of the changes introduced during the Covid-19 period (Section 3.4).

2.2.1 Arnstein’s Model: The Ladder of Citizen Participation (1969)

In 1969, some new ideas were put forward regarding the involvement of citizens in planning as a multidimensional action, which, according to Arnstein (1969), could influence citizens’ power in decision-making processes. In her study, she develops the concept entirely differently from what had been discussed until then in the field, specifically as it pertains to the level to which citizens can influence projects undertaken in their residential areas. Arnstein uses the symbolism of stairs to illustrate her point, by metaphorically paralleling each step with a level or type of citizen involvement.

Figure 6. Arnstein's ladder of participation



Note. Data source: (Arnstein, 1969)

Examining the levels starting from the last one points to manipulation. At this level, residents are neither participating in decision-making nor are they empowered; instead, they are utilized to push forward a preordained plan. This is usually achieved through public meetings and public hearings that do not function effectively to obtain citizen feedback. Such activities are frequently regarded as external tactics for facilitating participatory planning, designed to create an illusion of inclusiveness; however, they are fundamentally standard procedures, as the plans presented are pre-approved by the decision-making authorities (Cooke & Kothari, 2003).

Therapy involves another approach that is again based on real non-participation and is considered a type of psychological tactic that tries to instruct the public to adapt to the established system, instead of addressing institutional issues that have failed, or are not effective. This technique suggests that the issue resides with citizens who need to moderate their expectations, while decision-making authorities possess superior knowledge concerning their best interests (Lyles & Swearingen White, 2019).

In the third stage, a modest improvement is noted in the context of public information. Distributing information regarding proposed projects to the public is highly valuable and significantly enhances trust in the planning process, while augmenting transparency for residents. Numerous studies highlight that utilizing media for the dissemination of accurate information is a beneficial method, as it reaches a broad audience at no expense (Flyvbjerg, 2012). However, this remains a one-sided and non-interactive means of communication.

There are many countries in which this method of communication dominates and does not give the public the opportunity to share their opinion, implying a planning model where communication is simply an administrative procedure. Despite that, obtaining public opinions through questionnaires or public proceedings is one level of participation that can be considered partially participatory. Yet Arnstein (1969) emphasizes that the problem with this approach lies in the fact that, despite receiving citizens' opinions, the relevant institutions are not obliged to respond, thus demotivating people to remain active.

The level at which participation is not a symbolic act is the rung of partnership. It is essential that prior to this level of involvement, the public possesses the knowledge that will subsequently aid them in executing or formulating plans for their city. For this reason, social learning, which may be accomplished through consultations and conversations with a wide range of stakeholders, is regarded as an crucial component in order to foster collaboration and establish a shared comprehension of a variety of urban concerns (Collins & Ison, 2009). This process is dynamic as it is not reliant on fixed structures or pre-approved plans; rather, decisions are made by multiple stakeholders, considering numerous often-overlooked social aspects. At this level of participation, many actors effectively contribute to the decision-making process, leading to genuine cooperation between citizens and the state. The partnership is achieved through joint discussion boards, state councils, and some of the most innovative techniques, where people have access to any necessary data about project plans. Therefore, the proper interpretation of the concept of participation by each set of actors, such as public institutions, various agencies, and citizens, ensures that the initiatives undertaken actually coincide with the intended democratic goals. Consequently, to establish a coherent framework for enhancing involvement in urban planning, it is important to identify the most suitable activities, ascertain the most engaged segments of society, and determine the beneficiaries of these strategies (Cornwall, 2008). Arnstein posits that, alongside inviting participation in planning, the development of new communication methods is needed to establish confidence in transparency regarding decision-making and to acknowledge the actual requirements of citizens. Although this scale shows a massive change in the context of inclusion, compared to the aforementioned levels this cooperation risks moving back to the level of placation. Arnstein (1969) describes a higher level as the significant <u>delegation of power to citizens</u>, indicating that they play a crucial role in the planning process, albeit without complete autonomy. This is the most critical level at which citizens possess the authority to take real steps in various urban planning policies through specific programs and activities, but according to a well-defined regulation in state institutions.

At the top of this metaphorical system stands the <u>autonomy of citizens</u> to take decisions about their city. During this phase, citizens independently develop project ideas with the support of governmental agencies for technical, administrative, and other components. According to the author, this is the highest form of participatory planning with a grand vision to promote social equality through inclusion. However, it is crucial to highlight the difficulties and political and administrative challenges that must be overcome to reach this point in the planning process. This scenario assumes that citizens are consistently able and eager to engage with the management of diverse urban issues, which appears somewhat unrealistic given their potential lack of knowledge on certain aspects of the project and power dynamics that may exist within the community, thereby engendering inherent inequalities. Consequently, this planning paradigm may be inadequate due to its potential to engender governance problems. Establishing a planning system that fosters collaboration between public input and institutions within a balanced framework of power and responsibility is essential for attaining optimal outcomes in the planning process (Theyyan, 2018).

On the other hand, Arnstein model has often been considered a linear model, implying that higher levels are associated with more efficient participation, for which it is argued that successful participation need not be linked with full citizen authority in decision-making. In addition, there are many social, economic, cultural, and ecological factors that can influence participation, so it cannot be considered a sequential process, with its periods of growth and decline. Tritter and McCallum (2006) further strengthen this argument by contending that the Arnstein model's tendency to simplify the complexity of daily life may overlook important concerns. Hence according to Fung (Fung, 2006) varying urban and state contexts necessitate distinct participation tactics, with the structuring of this process being paramount, rather than the level of influence local actors possess in influencing this approach.

However, despite the critiques raised, this approach remains an important instrument for the reflection of each country's actual level of participation and inclusiveness, prompting decision-making bodies to enhance or modify strategies aimed at improving the well-being of the entire population and fostering sustainable urban environments. To conclude, the primary advantage of this framework lies in its foundational principle: those most impacted by the implemented policies play a central role in their formulation, thereby ensuring that these policies are tailored to their needs, in accordance with the guidelines established by the relevant institutions in legislation.

2.2.2 'CLEAR' - Participation Model

Lowndes, Pratchet and Stoker (2006) developed a new model of participation. In their model, they identified five critical levels of factors that directly influence citizen involvement in decision-making, as listed below:

- The first factor is "Can do" - which means that people are inclined to cooperate and get involved when they have the necessary knowledge and some key resources, such as spaces where consultations can take place, various means of communication, etc. According to the authors, capacity-building initiatives utilized to motivate citizens to be active can significantly improve this process.

- The second factor mentioned in the study is “Like to” - This notion encompasses the sentimental aspect of citizens who get motivated to engage in community activities when they possess trust in governing institutions and a profound connection to their community. Social cohesion, as a major indicator in building a healthy society, encourages cooperation and increases the sense of belonging and shared responsibility (Larsen, 2014).
- “Enabled to” - is another indicator of participation that highlights the role that organizations or shared structures such as community groups play in creating solidarity to cooperate. These groups usually serve as bridges between state institutions and the community.
- A factor that is usually neglected is the way in which people are invited to participate in decisions made for their residential area or for the community as a whole. In this framework, it is labelled “Asked to” and is about mobilizing citizens to signal that their voice is heard and matters. Wu (2016) asserts that the strategy based on this crucial stage should not be viewed as a limited bureaucratic formality, but rather as an effective means to engage residents in an approach that fosters trust, particularly in places where such practices are not yet customary or established as legitimate. Facilitating an easily understood way of communication and promoting engagement, while addressing cultural, social, and economic barriers among individuals with an assortment of knowledge and abilities, guarantees their effective participation in activities that impact them directly.
- “Responded to” – for participation to have meaning and a long-term vision, citizens must comprehend that their voices are being heard and influence the decisions that are made. Only in this way will citizens remain active in continuously being collaborative and innovative in ideas and activities that lead to improving the inclusivity impasse encountered throughout the world. To achieve this performance, transparency of governing institutions towards citizens in the decisions made and how these conclusions were reached is an essential need, i.e., a detailed reporting of the entire process.

In the context of all the aforementioned content, the CLEAR framework serves as a model that analyses the selected strategy to trigger citizens and help improve the level of participation in local governance.

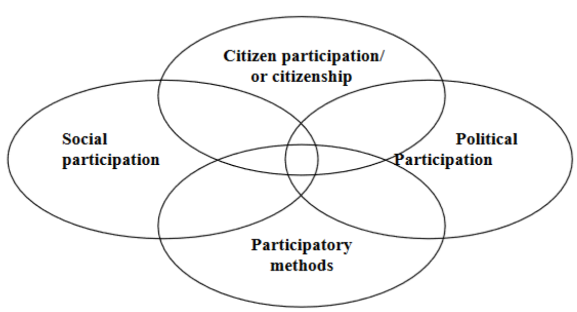
2.2.3 The "Power Cube" model

Gaventa's model (2006) presented an analytical approach towards levels of power in public involvement. Also known as the "Power Cube", this model, unlike other developed frameworks, looks beyond the absence or presence of inclusiveness in decision-making, emphasizing the relationship that exists between different forms and levels of empowerment through detailed critical analysis. Gaventa pointed out some principal issues that underscore both the importance and the potential of assessing the transformative effects of citizen engagement in local politics.

a. Redefining community and involvement

   In standard representative democracies, it is generally acknowledged that citizens express their preferences mainly through the electoral process, voting to choose leaders who will represent their interests. The duty of formulating policies and maintaining government accountability has historically been assigned to elected officials, who are anticipated to advocate for the interests of their constituents within legislative and administrative structures (Coglianese & Dahl, 1990). This model frequently restricts direct citizen involvement in governance outside of election periods, which raises issues regarding the effectiveness of representation and the degree to which public officials respond to changing societal needs (Pateman, n.d.). A fundamental reevaluation of both participation and citizenship within the context of local governance is required in response to the demand for innovative methods of promoting interaction between the state and its citizens. This transition necessitates a departure from conventional civic engagement models, which frequently prioritize periodic electoral participation, and the promotion of more deliberative, inclusive, and continuous forms of engagement. In this context, Figure 7 illustrates the connection strategies to participation.

Figure 7. The connection strategies to participation



Note. Data source: (Gaventa, 2003)

b. Evaluating each part of the solution

It is necessary to address both sides of the relationship in order to rebuild public confidence and participation in local governments (Fung, 2005). This entails focusing on the junction of state-led and public society-driven strategies rather than just one of them. Developing more inclusive and efficient local governance requires enhancing accountability, responsiveness, and engagement through creative governance models.

c. Linking participants and organizations

One of the primary challenges of the 21st century is establishing new and effective relationships between citizens and the institutions, particularly governmental bodies that shape their daily lives (World Bank, 2025). Achieving this requires the development of collaborative frameworks that facilitate ongoing engagement between individuals and institutions, rather than restricting interactions to periodic elections or policy consultations. Effective participation mechanisms encompass public forums, participatory budgeting, digital engagement platforms, and community-led initiatives, which collectively empower citizens to influence decision-making processes directly (World Bank, 2014).

d. The need for additional data

The creation of new platforms for participatory governance offers potential for transformative change; however, further investigation is required to assess their effectiveness, identify beneficiaries, and evaluate their impact on social justice. While some evidence indicates that these mechanisms may positively influence democratic development, research on their concrete benefits for marginalized and economically disadvantaged groups remains limited.

e. Considering authority dynamics in participatory spaces

Assessing power dynamics in participatory spaces is crucial for ascertaining whether these platforms truly facilitate revolutionary involvement or predominantly uphold existing systems that govern and control. Comprehending the dynamics of power in these contexts aids in evaluating their capacity to empower marginalized populations or, alternatively, maintain structural inequities (Fung & Wright, 2001).

2.2.4 Participation models after 2010

In response to the digital transformation brought about by technological advancements and the increasing demand for transparency in decision-making, public involvement in urban planning underwent a significant change after 2010. This phase focused on institutionalism and advancing the practices of real inclusion, unlike previous periods that emphasized democratic principles and theories. Decision-making authorities became more open to such changes, recognizing the advantages offered by technology and, especially, the public's participation in these approaches. Bryer's model from 2012, Scotland's Digital Participation Pathway (2014), the Engagement Triangle (2015), and others illustrate this shift. Bryer's participation model (2012) pointed out the importance of social networks in the propagation of information and the establishment of reciprocal ties to foster cooperation within the community and society. On the other hand, the Scottish model (2014) prioritized the design of public services understandable by the public, with a focus on marginalized groups, thus presenting a long-term vision for capacity building and ongoing participation, unlike many other models. Participation was now defined as a close relationship between three elements: decision-making with public involvement, the creation of sustainable relationships, and capacity building. This viewpoint was highlighted in the 'Engagement triangle' model (2015), which encouraged planners to assess over time whether the selected strategies serve to build long-term relationships and whether the tactics and initiatives undertaken for capacity building are helping citizens feel more involved in the entire planning process. Later, the capacity-building component was replaced with the dissemination of knowledge, removing barriers that could exist in terms of the skills, knowledge, and experiences that either citizens or decision-makers could possess. These models demonstrate that during the worldwide surge of digitalization, public involvement in decision-making emerged as essential for the effectiveness of policies implemented by governmental institutions.

2.3 Planning paradigms

In the evolution of planning models in the previous section, it is noted that historically, urban planning has gone through different decision-making approaches, starting from a completely top-down approach to participatory models. This sub-chapter critically examines these paradigms, arguing that they should not be viewed as oppositional but rather as models that must be integrated to create a more democratic planning process for developing sustainable cities while preserving social wellbeing.

2.3.1 Theories about political aspect of planning

Urban planning involves decision-making that reflects governance agendas and power dynamics, making it inherently political. The Oxford Handbook of Urban Planning states that urban planning decisions typically reflect political ideals and preferences (Thompson, 2012). The planning approaches of the 1960s and early 1970s overlooked the political aspect of urban planning. Beginning in the late 1970s, planning theory increasingly conceptualized urban planning as a political discourse. This viewpoint was further solidified in the 1990s with the development of the communicative method, which extended this concept by closely linking urban planning to politics and equating theory of planning with political philosophy (Pissourios, 2014).

Two significant concepts have influenced the country and town development during the last fifty years, according to Healey (Healey, 1992) . On one side, centralization has made decision-making more technocratic and separated from politics, giving technical experts more power. On the other side, there has been an increasing need for a larger involvement of the public in decision-making, with an emphasis on inclusive governance and participatory governance. The two tendencies can be characterized as the top-down and bottom-up approaches to planning, highlighting the distinction between centralized control and participatory decision-making (Murray et al., 2009). Given the political nature of urban planning, which is often top-down, effective spatial development must be a shared responsibility. A more open and participatory approach is needed to resolve stakeholder disputes over land allocation and ensure urban space utilization within socio-ecological and cultural contexts. Understanding citizens' urban environment views, values, behaviors, and attitudes is essential for significant reforms. In complex socio-ecological systems like urban ecosystems, bottom-up and top-down engagement tactics can promote system evolution and urban resilience. For a vibrant and sustainable urban future, these spaces must be resilient enough to adjust their architecture and functions to social changes (Semeraro et al., 2020).

On the other hand, because participation is influenced by historical, ideological, political, social, and cultural elements, it cannot be viewed in isolation from the particular social environment in which it occurs. Rather than adhering to a set model, its institutional structures are impacted by political choices that support larger societal goals. Therefore, depending on the institutional framework, the participating groups and the socio-cultural context in which participation takes place, different approaches are needed. Although many traditional cultures have rich and significant forms of involvement, their fundamental reasoning does not always coincide with modernization initiatives, especially those that are prompted by enforced frameworks or outside influences. Forms of involvement that naturally emerge inside a community but lack modernization tend to clash with externally imposed modernization that lacks authentic participation (UNESCO, 1986). This contrast draws attention to the conflict between naturally occurring, community-driven participation, and growth that is forced from without. Should old systems be discarded in order to formalize participation, or can they provide important, even essential, insights for creating participatory frameworks?

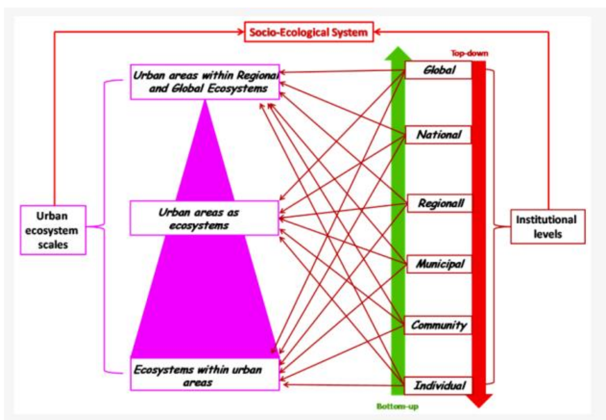
It is increasingly evident that, even in democratic societies where institutions facilitate widespread public consultation, the traditional model where elected representatives make decisions on behalf of the population for extended periods is often insufficient in rapidly evolving societies. For that, over the past decade the need for new strategies in urban government has been increasingly needed, highlighting the significance of including a varied array of stakeholders. The transition from a centralized, top-down approach to a more decentralized, bottom-up model in urban planning coincided with the changing focus of planning theory. As a result, several participatory spaces have been established, frequently launched by institutions. To ensure more inclusive representation, democratic systems must be reformed by incorporating new mechanisms and communication channels between citizens and decision-makers. In this context, participation can be understood as the progressive integration of previously excluded individuals into the institutional political framework (Coglianese & Dahl, 1990).

However, according to Miessen (2011), participation runs the risk of becoming merely a formality, which would reduce its innovative power. The environments created for participation may be reduced to cursory consultations with minimal impact on public decision-making, which is one of the paradoxes of participation. Rather than creating true influence, these procedures might largely be used to reach agreements and resolve disputes in an effort to restore the environment for "beneficial politics", which might be considered a worthwhile objective, but not enough in and of itself. Because of their access to resources and institutional networks, entities such as governmental bodies, private organizations, and well-established third-sector actors may deliberately create exclusive spaces where they can effectively participate in decision-making (Fung, 2005). Therefore, these participatory procedures might not be able to improve democratic inclusivity or drastically change power relations. Paradoxically, participation might exclude marginalized groups that lack the tools to properly advocate their points of view. This implies the need for a balance between top-down and bottom-up approaches, making the process more inclusive, transparent and effective.

2.3.2 Top-down planning

As previously noted, planning occurs in both a top-down and bottom-up mode. The top-down and bottom-up approaches to urban planning are frequently considered to be incompatible with one another. This is due to the fact that they have the potential to generate conflicts and fragmentation in the vision for the newly built environment, which can result in disparities between the various urban levels and the interests of stakeholders (Smith, 2014). In an ideal scenario, an urban area would be planned as a socio-ecological system, with dynamic interactions between the urban environment and institutional structures at various levels of analysis.

Figure 8. The relationship urban ecosystem scales- institutional levels in the socio-ecological system



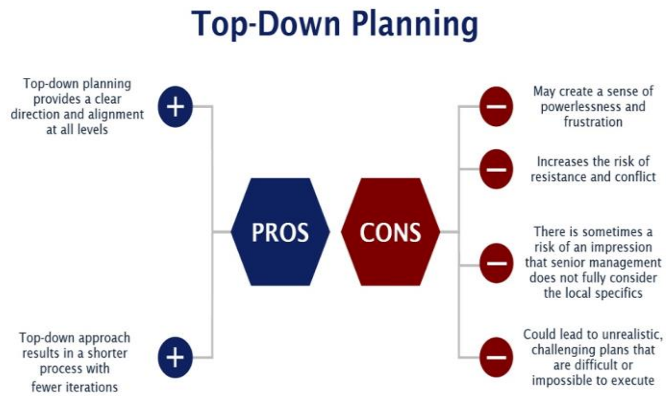
Note. Data source: (Semeraro et al., 2020)

Figure 8 shows a scheme of the relationship between urban ecosystems and institutional levels in the socio-ecological system. Top-down planning is denoted as the conventional approach wherein organized technical assessments underpin centrally formulated plans, then revised by specialists to conform to established objectives. It is a technique that begins with the broad vision and mission of the organization, and then gradually translates those aims into more precise objectives at every level of it. With just a fraction of focus placed on bottom-up dynamics, the majority of contemporary planning approaches are primarily driven by a paradigm that tackles planning from the top down. In general, this strategy is associated with a framework that is both centralized and structured and adheres to a methodical and hierarchical procedure, in which broad objectives that are established at higher levels are gradually developed into more specific targets, while frequently retaining a high-level perspective. The main characteristic of a top-down strategy (as shown in the Figure 9) is that it is initiated by policy decisions made by government officials, typically at the highest level and the implementation of these programs is typically delegated to governmental agencies (Dalal-Clayton et al., 2000). This approach then assesses a number of important factors (Sabatier, 1986):

a) Alignment of implementation: the degree to which the behavior of impacted groups and the actions of individuals in charge of carrying out the policy follow the original goals and specified processes.
b) Achievement of goals over time: the degree to which the desired results are met and if the long-term effects are consistent with the initial policy goals.
c) Influencing factors: the main components that impact how policies are implemented and what happens as a result of them, including those that are directly related to the policy and outside political factors that could affect how well it works.
d) A further aspect to take into consideration is how the policy changed over time in response to real-world experiences. This entails examining how early strategies were modified in response to practical difficulties, determining whether these adjustments increased efficacy, and determining the driving forces behind these adjustments, such as stakeholder demands, policy performance reviews, or more general political and socioeconomic changes.

Traditionally, urban planning and design have been conducted using a top-down methodology. This means that planners, who are considered to be experts in the field, prepare recommendations and offer them to decision-makers, who ultimately decide whether or not to approve the plans.

Figure 9. Top-down planning



Note. Data source: (FB&A, 2024)

2.3.3 Applied frameworks in policy implementation

Numerous researchers have created models to explain policy implementation, with some emphasizing a top-down approach and others endorsing hybrid models. In this research, only a part of them have been selected, which represent valid examples for the purpose of the study. The first framework studied for policy implementation was the Berman framework in 1978, which investigated the ways in which public support and acceptance, as well as the availability of resources, influence the process of policy implementation (Berman, 1978). In his model, Berman (1978) compared policy implementation at the macro and micro levels, where the macro level was considered the level that places a greater emphasis on the formulation of policies, the distribution of resources, and the regulatory perspective, while the micro level was considered the part of the system in which non-political organizations, corporations, civil society groups, and other similar entities are responsible for conceiving and implementing policies. Through this model logic, the main conclusion reached was that even if the policy at the macro level is well conceived, it does not necessarily guarantee that it will result in a successful implementation at the local level. This reasoning suggests that, other factors such as the availability of resources, the socioeconomic status of the local stakeholders, and their level of incentive to align themselves with the directives, all play a crucial role in determining the level of implementation that is carried out.

Another valuable framework is a theoretical model called Mazmanian and Sabatier framework, which aims to analyse and evaluate the implementation of public policies by identifying critical variables that influence their outcomes (Wittwer et al., 2017). Of particular relevance to this research is the fact that it highlights the importance of both top-down and bottom-up planning approaches. Furthermore, the factors that impact the success of policy implementation were divided into mandated and non-mandated, where mandated factors are covered by laws or regulations. In this way, these statutory variables help ensure that important operational processes are clearly defined, therefore enabling the shift of policies from cognitive frameworks to executable strategies and thus improving their practical relevance and long-term effectiveness. So, based on this model, the implementation of public policy can be seen as a braid of the following three concepts:

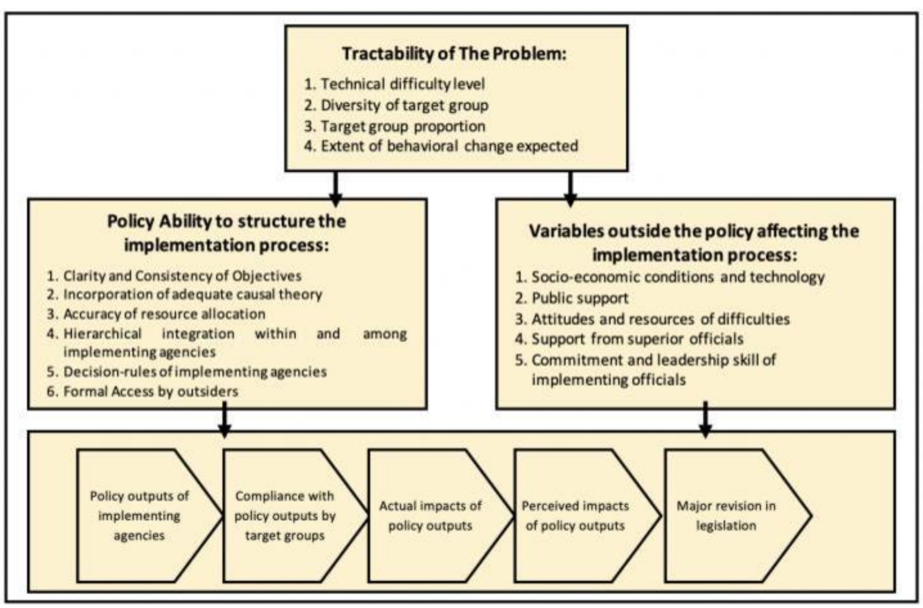
a. Tractability of the Problem

   Dealing with policy issues often involves technical problems that need specialized knowledge and new ways of solving them. In addition, the attitudes and responsiveness of the stakeholders and the total number of individuals affected by the policy determine the extent and magnitude of its execution.

b. Ability of legislation to manage implementation

   This component evaluates the efficacy of the policy's legal structure in facilitating implementation through the provision of explicit instructions, resources, and accountability mechanisms. This model is illustrated in figure below.

Figure 10. Mazmanian and Sabatier policy implementation framework



Note. Data source: ((Wittwer et al., 2017))

c. Non-mandated factors

To attain a comprehensive understanding of the factors influencing policy implementation in an urban context, it is essential to consider additional outside forces that are not addressed within any legislative or policy documentation, referred to as non-mandated variables. These factors are primarily related to citizens, particularly in terms of public acceptance. Some of the factors that can influence public acceptance are the technology aspect concerning access to information and platforms, the social and economic state of the community, financial support, trust in the decision-making institutions, etc. In this model, the importance of full citizen participation in policymaking is implicitly underlined as a key element for increasing public acceptance, increasing assurance that the policies undertaken meet the real demands and needs of the public, and creating a safe and effective implementation path.

However, numerous studies assert that the policy implementation process in traditional planning methods has been considered as a linear sequence of actions that followed several procedural steps, resulting in ineffective implementations for society. In this context, Goggin's policy implementation study (1990) by advancing the Mazmanian and Sabatier framework, asserted that successfully implementation depends on regular consultations between legislators and implementers as well as on the clarity and consistency of these interaction, thereby pointing out the urgency of considering cooperation among several levels of government. In addition, Hill and Hupe (2007), by considering this process not as a fixed process but as a dynamic one that consists of a series of actors with different levels of power reinforced the importance of strategies for designing and implementing different policies, indicating that the two paradigms of top-down and bottom-up planning must be intertwined to succeed in the initiatives undertaken.

2.3.4 Criticism of the top-down approach

As previously stated, the top-down style of governance in planning is a centralized method that begins from the standpoint of elected officials. This planning approach encounters numerous obstacles when there is no explicitly designated agency or organization responsible for overseeing the comprehensive process of policy implementation. Numerous urban projects have failed despite excellent policy design because they were based on a top-down approach that excluded citizen involvement. Scott (2020) in his study took this aspect into consideration based on major projects that failed. One of his main arguments regarding the topic is that decision-making guidelines tend to generalize about a society that may be more complex than methods that are too rigid and bureaucratic, often introducing problems that are not considered in the early stages of policy design. This is considered an overestimation of this strategy, where leaders are confident that they can design urban practices while disregarding the public's experiences and fears regarding their urban area. This way of working reduces the chances that the initiatives will be fully effective and beneficial for the majority of residents who face it every day. So, the drive to ‘hide’ or simplify the complexity of urban life for enhanced manageability and project design results in the neglect of numerous critical aspects, ultimately yielding suboptimal and detrimental initiatives over time (Saiu, 2017). Therefore, the belief that plans led exclusively by experts will perform better is a relative paradigm that should be critically examined. This is because bureaucratic procedures can create cities that are not sustainable for a long time to adapt to changing needs.

The issue was also highlighted by Jacobs (Jacobs, 1992); in support of mixed residential areas for community engagement, she articulated a series of critiques regarding the top-down approach and the inflexibility of this methodology employed by various nations worldwide for years. Mixed residential areas are identified by the integration of cultural facilities, commercial advertising, green spaces, and entertainment within a single location where, according to Jacobs, this diversity encourages collaboration for the collective benefit of residents. But this perspective is usually ignored by urban planners who undertake major projects with the aim of redeveloping areas that have resulted in poorly organized development into areas divided into different topologies. The perspective of the planners and decision-makers is founded on a number of highly technocratic goals, such as creating a well-organized city by displacing traditional urban centers, clearly defining the types of commercial, residential, and industrial areas, and creating circumstances that would allow residents to have equal access to infrastructure and resources.

In these conditions, making decisions detached and distant from the community frequently results in the creation of socially isolated neighborhoods. Therefore, it is more important to consider the daily activities of citizens in their area and their human connections, a concept referred to as 'eyes on the street' by Jacobs. This term emphasizes the efficacy of organic, informal observers, such as those monitoring heavily travelled or crowded areas, when compared to traditional, fixed evaluations. From this point of view, cities should not be regarded merely as a collection of resources and infrastructure, but rather be perceived through an expanded perspective that encompasses the daily urban experiences of the residents.

These approaches support public participation in urban planning; therefore, they accept the shortcomings and limitations of following a strict, homogeneous framework that ignores the entire capacity of society in creating a sustainable city. Another aspect of this planning approach is that cities are built all at once, unlike traditional ancient cities, which evolve and change gradually over time to meet the needs of the population (Kolb, 1990). As a result, it is important to note that another major problem with this approach is that the built city cannot adapt and change all the time. Furthermore, many researchers argue that city development is now considered more like a business that needs and provides income rather than a public duty or service (Saiu, 2017). This stems precisely from the arbitrary nature of protocols and regulations constructed, which predominantly emphasize the profitable dimension of an initiative above the environmental and social dimensions. In summary, most criticism suggests that urban models do not adequately represent the complex realities of urban environments; instead, the long-term sustainability of cities depends on participatory planning and social equality, rather than solely on environmental protection measures like green transition, smart infrastructure, and carbon reduction.

2.3.5 Successful examples of top-down planning with integrated participatory mechanisms

Despite the many criticisms that exist against the top-down approach in urban planning, there are examples of developed cities that have successfully applied this planning method by effectively integrating participatory mechanisms within their planning strategies. The following sections describe the planning models implemented in Singapore and Copenhagen in detail, analyzing the factors that have contributed to their success depending on the urban context.

Singapore and Copenhagen as illustrative cases

Starting with the urban planning approach in Tirana (which will be discussed in more detail in the next chapter), top-down planning prevails, where citizen participation is almost nonexistent. Such an attitude is one of the reasons why citizens often feel dissatisfied with the reforms undertaken and are distrustful of the decisions taken by the relevant authorities. The lack of transparency in urban decision-making has made citizens feel completely unmotivated to be active in protecting their city through mechanisms initiated from below, through bottom-up initiatives. There are organisations and activist groups that work in this direction, but the underestimation of institutions towards their calls often causes these movements to fade away or turn into conflicts, impacting the implementation of urban projects. Meanwhile, there are cities in the world that have managed to flourish in this aspect by best integrating bottom-up tactics into the overall top-down approach. In this research, two cities, such as Singapore and Copenhagen, have been selected as case studies since they represent successful models of institutionalized participation in the top-down approach. It is true that the context of Tirana differs significantly from that of Singapore and Copenhagen; however, the selection of these two cases was made to highlight the institutional and innovative gap that characterizes participatory processes in Albania. In this sense, technology-enabled civic participation practices in Singapore and Copenhagen are not treated as transferable models but as analytical tools to understand effective mechanisms of inclusion and to deepen the discussion on the limits and possibilities of real participation in urban contexts in transition like Tirana.

2.3.5.1 Singapore's urban planning model

Singapore exemplifies how effective top-down planning, when properly implemented and organized, can achieve exceptional results. It's development adheres to a multi-tiered framework comprising long-term strategies, primarily predicated on projections of demographic and economic transformations over the next 50 years; master plans that operationalize long-term strategies and typically span 10 to 15 years; and short-term plans that address unforeseen circumstances. The primary advantage of Singapore's planning paradigm is the incorporation of artificial intelligence (AI), simulations via diverse software, and the processing of spatial data using machine learning (ML) techniques (CLC, 2022). In this city, although about 80% of the population resides in state-designated dwellings and areas, each residential neighborhood is varied, fostering harmony among its inhabitants. This is closely related to the theories that emphasized the importance of preserving the nuances and diversity that make up urban environments in encouraging shared responsibility and collaboration for common social wellbeing (Jacobs, 1992; Kolb, 1990; Saiu, 2017). In addition, Singapore, a global leader in climate change adaptation and sustainability, has included environmental preservation into every aspect of its urban planning regulations (Forbes, 2024). Despite being a top-down approach, the long-term vision and green policies implemented render this strategy crucial, demonstrating that sustainability is an essential foundation for urban planning rather than only an objective to achieve by the SDG 2030.

Digital solutions for smart urbanism in Singapore

Significant insights into the major mechanisms built to handle challenges associated with conventional planning approaches may be gained from Singapore, which serves as one of the most digitized nations in terms of tackling urban complexity and offers considerable observations into these processes. According to several studies, the majority of this advancement took place during the COVID-19 pandemic, which was a time when the implementation of remote systems and preventative measures for social distance were absolutely necessary. In this context, technologies were rapidly developed, including automated agents in public areas, real-time mapping of overcrowded regions to avoid human contact, and various health units using AI. A web-based map was developed in Singapore in the year 2020, with the purpose of tracking the total number of people who visited specific areas, such as public spaces, parks, and retail malls, among other possible places of interest. By incorporating a number of webpages and a variety of software applications into this system, it became feasible to automatically gather data and maintain it in the cloud's structure. Furthermore, a series of robotic simulations and systems were created to help raise people's awareness of social distancing and prevent further spread of the virus. Here can be mentioned the four-legged robot SPOT, which, through several incorporated sensors, allowed for distance monitoring in public environments and beyond. The effective use of technology during the pandemic period paved the way for many other developments in this smart city, taking into account long-term sustainability and urban resilience.

1. BuSCOPE is a system that analyses public transport data in real time by assessing various commute patterns. This platform predicts the number of passengers disembarking from every vehicle and forecasts urban dynamics that may result in traffic congestion. This capability enhances civic responsibility in preventing accidents and unnecessary movements while also improving the authorities' ability to respond swiftly in emergency situations (Meegahapola et al., 2019).
2. OneTool is a sophisticated technology that helps planners to accurately design, model, and forecast a range of urban demands (URA, 2021). This platform utilizes ML techniques and algorithms to do predictive assessments, including population expansion and distribution, housing and service requirements, and to uncover latent patterns within the information that was provided. Integrating AI and ML algorithms for comprehensive analysis and future forecasting on this platform facilitates predictive planning, preparing specialists and decision-

makers for forthcoming requirements (*Smart Planning*, n.d.). Consequently, these entities can foresee potential hazards and risks stemming from climate change, demographics, and other factors, facilitating their progression towards establishing a smart city.

3. Another software created within the framework of urban management specifically for parking is DeepPA. DeepPA is an ML-based platform which, through the establishment of a dataset called SINPA storing all reserved parking spaces, applies advanced ML analysis and algorithms to predict free parking spaces. The utilized algorithms are advanced deep learning models that facilitate the identification of relationships among the various factors affecting this matter (Cao et al., 2024).
4. Virtual Singapore is a dynamic 3D platform that functions as a digital twin system and enables the simulation of different urban scenarios through the integration of various data sources (Lopes, 2024). This advanced and complex system, in addition to monitoring urban issues in real time, allows experts to design infrastructure plans in an optimal manner. Virtual Singapore includes AI in processing and analyzing data through ML, IoT in incorporating sensors to have an accurate model in the digital twin and Big Data in collecting and managing a staggering amount of data in the Data Warehouse. This multifunctional platform offers valuable additional features, including the ability for planners to simulate and assess traffic in specific areas for improved management, incorporate climate conditions into energy and water consumption analyses, and manage natural disasters through preliminary simulations and plan development. Moreover, this application is accessible to citizens via various collaborative instruments, like:
   - Citizens can examine forthcoming urban plans, thereby enhancing the governance transparency for the public
   - Citizens may provide feedback on proposed projects and articulate their grievances regarding various urban issues, including traffic and waste management etc.
   - Additionally, because it is a 3D system with an easy-to-use interface, citizens can perform different simulations on their own, enhancing their understanding and preparedness for emergency situations.
   - Based on data the platform provides about specific trends, the most popular locations, etc., it can assist citizens in creating business ideas.

- The concept of sharing responsibility is established and citizens are encouraged to participate in the planning of their areas to ensure that the city's development aligns with the community's needs through this system, which is widely accessible to them.

As consequently, Virtual Singapore is not a tool that is targeted solely towards planners and decision-makers; rather, it is open to the entire community, which includes researchers, businesses, and other entities (Sabu, 2024).

2.3.5.2 Copenhagen's urban planning model

Copenhagen is ranked among the cities with the highest social well-being in the world as a result of comprehensive initiatives undertaken over the years. Furthermore, it is considered one of the most sustainable cities globally because of its developed smart infrastructure, investments in environmental protection, preservation of green spaces, etc. Being such a developed city, and since urban planning is based largely on a top-down approach, Copenhagen constitutes a very significant case study for this research. This section examines how urban planning has been conceptualized in the city over the years, what smart initiatives have been undertaken, and how citizens have been involved in these processes. A special place is occupied by the Finger Plan, which laid the foundations for effective city planning, followed by a series of innovative and comprehensive technology-based initiatives.

Finger plan

Copenhagen's urban planning, like Singapore's, serves as one of the most successful examples of the top-down approach. The planning of this city was dominated by several major projects such as the Finger Plan and the Orestad development. These plans were built on the hypothesis that demographic growth and urban sprawl would be impossible to stop after World War II. Therefore, in 1947, with the aim of preventing the city from expanding uncontrollably, the Finger Plan initiative was introduced, which in itself constituted a working strategy with a very broad and structured vision (Sørensen & Torfing, 2019). According to this design, Copenhagen's development should be modelled like the five fingers of a hand (as shown in Figure 11), with the palm serving as a metaphor for the center and each finger representing a departure from the city center via highways and railroad lines. The spacing between the fingers were planned to incorporate green areas and recreational zones, so preserving the city's vegetation. This initiative effectively established protected natural zones amidst urban developments, promoting sustainable land use. In other words, the plan was based on two main pillars such as:

1 Connecting the city with public transport. Thus, the construction of residential areas, businesses and service centers to be easily accessible by people – subjectively related to the idea of fingers.
2 Subjectively associated to the space between the fingers of the hand, the establishment of green public spaces where construction was prohibited in order to protect the environment and socialization through shared recreational areas is regarded as a very important aspect in urban development.

This policy not only enhanced the city with green spaces for each housing block but also prioritized public transport, so decreasing the number of cars and mitigating air pollution from emissions (Knowles, 2012). As was already indicated, the primary objective was to prevent erratic and disorderly urbanization, as this would have numerous detrimental long-term effects on the city. Finger Plan, with its simplicity in visualization and strategy, managed to make Copenhagen the most sustainable and accessible city in the world. Based on today's terminology, this plan can also be seen as a bottom-up approach because it first secured a great deal of support from local actors and was then defined in the official development plan of the metropolis by decision-making institutions, transforming it into top-down planning. Rorbech (2011) describes this strategy as a brilliant plan for large metropolitan areas. The drafting and planning were led by experts but again was inclusive, making it a politically and publicly acceptable process by the community. Helsinki and Stockholm are two metropolises that have generally adhered to this strategy, and in an era where urban planning must evolve to meet contemporary demands, the enduring nature of this plan is a significant tribute to its success.

Figure 11. Finger plan realization

Note. Data source: (Gaál & Horváth, 2017)

Based from the studied literature and the preceding description, it is imperative to identify the principal contextual and underlying factors that contributed to the success and sustainability of the Finger Plan in Copenhagen.

- The proposal was introduced immediately following World War II, during a period when the populace was yearning for a renewed sense of positivism, peace, and optimism for their nation and their life (Sørensen & Torfing, 2019). A new direction was coming as demands for housing, transportation systems, and free entertainment spaces had greatly increased (Kingdon, 1984).
- The professional autonomy offered to planners, architects, engineers, and environmental specialists in Denmark enabled them to formulate and devise increasingly ambitious designs, thereby swiftly augmenting governmental backing.
- This plan had the potential to emulate other successful initiatives of that time frame, such as England's, although there were quite a few changes and adaptations to the terrain, geographical and demographic differences between these two countries.
- One of the most significant pillars in this long-term plan was the recognition of the importance of preserving green spaces by legitimizing them in official sanctions and regulations. The concept of this initiative aligns perfectly with the objectives of the Danish state, recognized as a welfare state (Vāhāmāki, 1986).
- This plan was based on a metaphor that fundamentally featured a straightforward program for implementation and, most importantly, for conceptualization.

In the end, this strategy, even though it was implemented from the top down approach, made it possible for planning experts and the government to work together and prioritize the city's long-term growth (Ansell & Gash, 2008). Orestad exemplifies a contemporary urban district in Copenhagen, established in 1990 in accordance with the Finger Plan. The initiatives implemented in this area are only augmentations or expansions of the previously indicated plan. However, despite the objective of the Orestad plan to create a region that seamlessly integrates sustainability and architecture for the future, it faced numerous objections and dissent from the public. The community's participation in these processes was negligible, but efforts are ongoing to address these issues (Ösgård & Spierings, 2021).

Digital solutions for smart urbanism in Copenhagen

Copenhagen is among the most sustainable and affluent cities globally, having effectively executed numerous investments and efforts for environmental conservation, particularly in transit, infrastructure, and the preservation of green spaces (Smiley et al., 2022). The city's well-organized transit infrastructure, which was created early with the Finger Plan and is continually being enhanced to meet changing requirements and expectations based on demographic, social, cultural, and economic aspects, is evidence of this. The incorporation of technology into public transport has alleviated urban traffic congestion and notably diminished the reliance on personal vehicles, hence decreasing air pollution from detrimental automotive emissions. Furthermore, more than 40% of Copenhagen residents utilize bicycles for transportation within the city. A crucial element that contributes to Copenhagen's position as a frontrunner in smart city strategies is participatory planning. The community engages actively by offering their insights and suggesting potential solutions related to the urban issue at hand. This approach enhances the confidence of the community and their adherence to the initiatives implemented (Peštová, 2022). Copenhagen, being one of the smartest cities in the world, has a series of innovative applications that are worth mentioning. All of the following systems serve to improve the quality of life of citizens with an emphasis on the environment and how technology can serve this purpose. Some of them are briefly described below.

- Lighting with IoT sensors is used on the city's streets, which only operate when there is movement, leading to a reduction in energy use of up to 76% and monitoring road activity in real time, which can be valuable for increasing safety and traffic management by institutions that have access to this data (Itron, 2019). The software designated for this function is referred to as CityManager.
- The Copenhagen metro system is one of the most advanced systems in the world due to its autonomous management using real-time data analysis through AI and predicting different situations and conditions, thus reducing delays and optimizing passenger distribution (Insausti, 2024). This system, which serves the city to fulfill one of the fundamental goals defined long ago in the Finger Plan as a very ambitious vision, is based entirely on technology. Some of its most important functionalities are as follows (Hansen, 2011):
    a. The first and most important subsystem is Automatic Train Control System that manages the movement speeds and ensures that each component is in order before departure. Since it is an application entirely based on advanced technologies, this part serves as an autopilot

that monitors all the surrounding factors in record time through IoT sensors and AI techniques.
b. The system that uses specific sensors for safety alerts on the journey.
c. The centralized central system that is provided on a central computer and monitors all the activity, predicts the movements and possible defects by ensuring the continuity of this system as a whole.

- Given that more than 40% of inhabitants utilize bicycles for transportation within the city, dedicated routes have been established in Copenhagen to allow them to bypass traffic signals (The Guardian, 2014). One of the designated platforms for this type of transportation system is referred to as MobiMaestro which is used to inform about traffic and generate AI predictions thus motivating citizens to use these environmentally friendly means.
- Enhancing energy efficiency is a key goal of sustainability, and Copenhagen has established a well-organized energy infrastructure utilizing advanced AI, machine learning algorithms, and IoT sensors (Bramstoft et al., 2019). This network utilizes renewable energy sources efficiently, and each flat is equipped with a device that informs residents about their energy consumption, so enhancing individual accountability (Pallesen & Jacobsen, 2018). The apps utilized in this context include KMD Energy Management and ArcGIS.

Participatory planning strategies in Copenhagen

Although the planning model is top-down, public participation has always been considered a key factor for the success of policies undertaken in Copenhagen. This can be proven in the steps taken to involve citizens in the Finger Plan, which started from the bottom up and then became a national part of the city's development. While past years presented numerous hurdles for this involvement, the integration of technology today has streamlined the process, even for less developed nations.

Throughout the years, the strategies and models employed by decision-making institutions and planners have evolved, consistently emphasizing genuine participation that facilitates the exchange of opinions and concrete requests, alongside the sustained engagement of citizens.

- In 2023, a digital platform was established to invite residents to make recommendations for enhancements to their urban environments or for projects they were aware of that were in the planning stages. In a very short time, this framework had many users and today it is a consolidated system that is widely used by the citizens of Copenhagen. The functionalities offered by this comprehensive application are well-structured in a workflow such as:

registering citizens to ensure that they are actually residents of the city to avoid analysis on unreal data that may directly affect the distortion of the conclusions obtained or the predictions made; posting of suggestions by citizens which are visible to each other and affect the cooperation between them; there are different voting mechanisms for proposals made by the citizens themselves; evaluation of proposals by the responsible units and finally the implementation of proposals that are evaluated more positively and efficiently by informing citizens about the continuous progress on the proposals made. It is this transparency of the entire process that motivates citizens to actively participate in urban issues that matter to the community (Collaborative on Citizen Data, 2024).

- The participatory design of public spaces in Copenhagen effectively creates environments that reflect the cultural uniqueness of the regions and the needs of the local population. “Superkilen” is a highly successful project that exemplifies a global standard for inclusivity in park design within the Nørrebro area (AlShehri, 2017). This project is distinguished by its emphasis on community involvement in the area’s design, facilitated through regular discussions and diverse activities such as workshops, among others, to define the program. All citizens participated by contributing their cultural heritage and familial customs, with over 50 distinct nationalities engaged in the design of the park's most significant features. This indicated that in this communal environment, all participants contributed to a multicultural legacy, rendering this project a symbol of global inclusivity.

Figure 12. Superkilen Plan

Note. Data source: (*Intervención Urbana. Proyecto: SUPERKILEN PARK, Copenhague Dinamarca. – Proyectos 6. Apuntes de Arquitectura.*, n.d.)

“Superkilen” was designed in such a way as to be highly functional but also to meet the social needs of citizens, therefore as shown in Figure 12, it was conceived in three main parts:

- Red Square: a space that would serve for sports and cultural activities of citizens
- Black Market: a communal area for social interaction featuring shared benches and tables

    - The third and most significant aspect is the provision of green space for picnics and various outdoor activities.

  This park has received multiple international prizes, including the Honor Award from the American Institute of Architects in 2013 and the Aga Khan Award for Architecture in 2016 (Wenande, 2016).

- In Copenhagen, various activities (workshops, interactive discussion sessions, etc.) are often organized to co-produce various urban plans, creating citizen-centered environments. This work strategy creates a sense of collaboration between experts and local actors to design the area where they are part of different phases of the project and, above all, has given a dynamic and inclusive character to the urban planning process. In this case, it is interesting to mention the study conducted by Carroll and Nørtoft (2022) in Sydhavn, one of the low-income areas of Copenhagen. As a result of the significant population decline in this region, the responsible institutions have been populating it with families experiencing socioeconomic problems. The project undertaken mainly involved citizens who were more distant from the planning of their area due to their age or ethnicity to somehow fulfil the objective of inclusiveness in planning. One of the most successful methods used was <u>interactive maps</u> where residents marked the most and least frequented areas and also visually provided ideas on how these parts of their neighborhood could be improved. At the conclusion of the study, the authors contends that inclusive design need to be regarded as a prolonged and iterative process, as this mindset fosters the development of environments that are more aligned with societal contexts, particularly those segments of society frequently excluded from this process.

There are a series of studies and online platforms that most effectively illustrate how successful the inclusive model used in this leading city in participatory governance is—offering a framework that combines transparency, long-term sustainability, and innovation in urban planning. In addition to the initiatives and strategies employed, this positioning has been made possible by the institutions' recognition of these efforts through valid policies that facilitate their efficient execution and guarantee that they align with national objectives.

2.3.5.3 The participatory paradox of Singapore and Copenhagen

In the two sections above, it has been explained how urban planning works in two highly developed cities on a global scale, such as Singapore and Copenhagen, as two very positive examples of the top-down approach to urban planning. Based on the principles of this approach, which involves centralized decision-making by responsible institutions, there are some fundamental differences in how the decision-making process is considered in these two cases. The urban planning in Singapore is supervised by Urban Redevelopment Authority (URA), as was previously indicated, and state-predetermined models are typically used to design policies. According to Yuen (2011), the ability of authorities to manage urban development through centralization of authority has led to the successful implementation of large-scale plans and the provision of services very effectively to citizens within very short periods of time. The frameworks established in regulations involve initial discussions with individuals, conducted both in person and via advanced methods for gathering public feedback. However, this type of development is a top-down planning paradigm since the decision-making authorities have complete control over urban development, even though public involvement takes numerous forms. Moreover, inclusive policies often serve as a tool for gathering public information within a defined framework (Ho, 2016). This approach of functioning has resulted in significant development and advancement inside the city, but people continue to play a supporting role in its development, but with limited control.

Similarly, in Copenhagen, the planning approach is top-down, meaning it is led by decision-making authorities. The Danish planning system has been shaped by national top-down models, starting with the Finger Plan in 1947 and later by strategies that essentially had the same working structure (Knowles, 2012). In this city, citizen involvement is efficient because it is promoted through various techniques provided in regulations drawn up by the relevant institutions, but they are usually not used to change the principles of the methodologies used (Olesen, 2022). This hybrid management model where everything starts from the decision-making bodies and uses successful mechanisms to involve citizens in this process has made these two cities flourish both economically and in terms of the well-being of the population. Therefore, these two cases illustrate best how a top-down approach can be shaped in a way that is successful implemented.

2.4 Smart city as participatory environment

In recent years, the development of information and communication technology has made great progress, transforming not only local infrastructure but also accelerating globalization (Saba et al., 2024). The use of technology in various forms and levels has significantly impacted the daily activities of people, making actions and services more efficient in all aspects (Amine, 2023).

Global markets are becoming increasingly interconnected and collaborative through online platforms. These developments have changed the way of governance, of doing business, and interacting with citizens.

But at the same time, the world is facing major changes that have affected fundamental aspects of its functioning, such as the problem of urbanization. Global urbanization, within a very short time, has brought a series of obstacles, among which it is enough to mention the ever-increasing need for resources and the complexity of urban management that not only urban planners but all people are facing in different ways. Considering the numerous benefits that technology offers in data processing and beyond, the smart city concept immediately became a necessary goal and objective to survive in such a difficult time where management must be optimal not only to protect natural resources but also to ensure high well-being for citizens. But first, it's vital to know what a smart city is, what principles it must meet, and what issues technology-led intelligence brings. The concept of a smart city is quite broad, and there is no single definition that encompasses it; however, this research selects some of the most important definitions that maintain the focus on participatory planning through technology.

According to Mohanty (2016):

- A smart city is a place where traditional services and networks are more sustainable with the use of technology to streamline daily operations for the benefit of its residents.
- A smart city is an advanced urban area that employs information and communication technology to enhance citizens' quality of life, aligning improvements with citizen demands and socio-economic factors while considering sustainability for future generations.

The two definitions above clearly demonstrate the close relationship between this broad concept and citizens. Specifically, it pertains to the well-being of citizens, viewing technology as a tool that serves their needs. It is precisely this way of using the advancements and benefits brought by various data-based platforms and systems that should be applied and further promoted on a daily basis. This perspective is not simply a different approach to this tool or instrument but is a necessity to ensure that technology is being used in the best possible way while having a long-term vision.

This is further reinforced by Kim (2021), who defines a smart city as an area that connects physical, technological, social, and business infrastructure to benefit from the city's collective intelligence.

The British Standards Institute (BSI) argues that a city is considered smart when it effectively integrates digital, physical and human systems into an environment to ensure a sustainable and inclusive future for its residents (British Standards Institution, 2014).

It can be inferred from the previous discussion that the technological systems encompassed by the term 'smart city' are primarily necessary for reading and understanding urban environments. In this case, reading the city involves analyzing its current situation to clearly understand the problems, challenges, and critical points of the city's infrastructure in real time. In this context, Chen (2010) argues that it is essential to sensitize the city to collect data and information. Therefore, by unpacking this big term of smart city, it can be discovered a side that is often lost or implied in the given definitions – the human side of the city! It is precisely this aspect that makes it possible for the above-mentioned reading to be realistic. Only by having a realistic overview of the situation in the city can optimal solutions be found with far-sighted objectives for future generations. But to reach this stage, radical transformations must be made in the way urban challenges are solved. There are many developed cities in the world which have understood that development comes from collective intelligence, as Kim (2021) mentions earlier in this section. These are cities that have flourished in key urban aspects, including economics, infrastructure, and, above all, the fundamental issue— the social well-being of their citizens. The previous sections of this chapter discuss two of these cities, Singapore and Copenhagen.

In light of the preceding discussion, it is imperative to assert that Tirana is not yet a smart city. In the introduction to the previous chapter, the current state of urban planning and management in Tirana was briefly discussed. Given the problems and challenges faced by both this city and all of Albania (which will be discussed in more detail in Section 3.5), it is somewhat understandable why development is not at the proper level. Although more could have been done for economic, infrastructural, and social development, today, there are ample chances to progress in various areas. Technology is a tool that knows no boundaries, and evidence has indicated that it offers extraordinary potential in all aspects of urban life. Citizens are using it more and more every day, and a change in management has also been felt in the city thanks to online systems. But again, the understanding of the benefits that those systems can bring to decision-making remains limited. This issue may not only stem from a lack of understanding of the technology's value but also from other factors, including insufficient experts for securing urban data, inadequate infrastructure—

particularly in rural areas—and limited funding for financing these initiatives. But above all, what can be said with conviction is that there is a lack of a clear and far-sighted vision in the use of technology to fulfil the main principles of sustainability in the city.

However, the use of technology to move towards the development of a smart city is also associated with several threats that must be handled very carefully. Therefore, developing the necessary infrastructure is crucial to maximizing these potentials and ensuring optimal data use. To relate this to the Albanian context, the lack of this infrastructure makes the aspiration to transform into such a city even more difficult.

2.4.1 What makes a city smart?

Smart cities around the world differ from each other, as they have different development paths and different needs. This difference is influenced by a series of factors such as geographical location, economic and social conditions, governance model, level of technological development, culture, etc. For example, some smart cities may focus on digital infrastructure to grow the country's economy while others focus on sustainability or providing basic services through technology. As a result, each of these cities is developing in certain divergent directions with specific challenges and different goals. This variation underscores the necessity for a development model that can conform to the realities and standards of the Sustainable Development Goals (SDGs) (Mohanty, 2016). But it is difficult to create a model on a global scale that adapts to the reality of each city that has completely different realities, needs and standards. IEEE has developed a general standard for the components that smart cities should have, including IoT, eHealth, smart grids, etc. (Logvinov, 2019). According to Caragliu (Caragliu et al., 2009), smart cities should have the following characteristics:

- The city must operate as an integrated system that facilitates economic advancement and social, urban, and cultural growth through the amalgamation of many systems, including technology, business, and housing (Hollands, 2008). In this setting, the city should be considered a dynamic system, which not only facilitates daily processes through the connectivity it offers but also promotes innovation, competition, and, above all, transparency and public involvement in decision-making models for greater sustainability and efficiency in the initiatives undertaken.

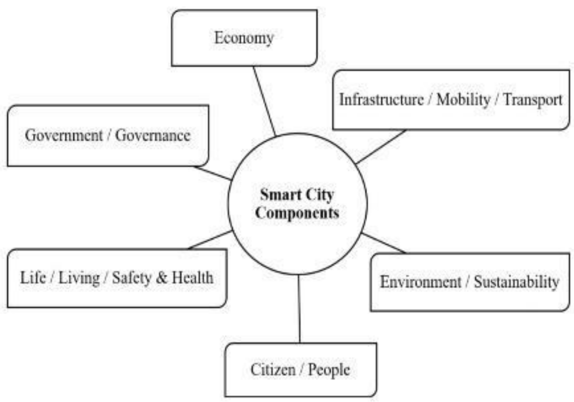
- Prioritizing business in urban development is another characteristic associated with the smart city concept. There is much criticism of this approach because it is considered a neoliberal vision of urban space where the fundamental goal is to attract investment and businesses (Vanolo, 2014). According to these critics, often relying too much on the financial aspect, these cities neglect aspects related to social justice and the environment. However, studies have shown that business-orientated cities perform very well in terms of socio-economic conditions (World Bank, 2009). This shows that striking a balance between economics and inclusive policies can work successfully in shared urban well-being.
- Focus on social inclusion through smart city initiatives. Here can be mentioned the multifunctional 'Southampton SmartCities' card, which was developed in Hampshire, UK, is a characteristic that these cities should have (Southampton City Council, n.d.). This card serves as a real example of smart city initiatives to facilitate accessibility of public services by ensuring that these advanced technological systems are accessible to all citizens.
- Urban development should give due importance to social capital. According to Coe (2001), a city will be smart when the community learns how to learn, adapt and be innovative. McClellan (2017) asserts that the system has attained intelligence through the integration of several technological components, and that the degree of intelligence applied to them should derive from multiple attributes such us:
- Effectiveness – a smart city should prioritize initiatives that generate measurable value for citizens by increasing their quality of life through infrastructure development, improving public services, and ensuring that investments in digitalization are directly beneficial to them (Moran, 2018).
- Environmental responsibility – a smart city must integrate environmental responsibility into its functionality and planning through policies for optimal use of energy and other resources, development of a sustainable transport system, etc. (McDaniel, 2023). By integrating environmental issues at the core of every level of urban development, smart cities can effectively address the challenges associated with climate change and globalization.
- Innovation – Cities can design efficient mobility systems, waste management, energy, and public services through the use of advanced technologies such as IoT, AI, Big Data, etc. Therefore, innovation is positioned as an engine that drives urban development and the transformation of urban challenges into opportunities (Wallin, 2023). In this context,

innovation is not simply about adopting technological advances but about improving key urban aspects to be more responsive to the growing demands of citizens.

2.4.2 Smart city components

In the previous section, the main characteristics that a smart city should have and the basic principles that it should fulfil were discussed. So far, this concept has been treated as a system that uses technology to ensure high social well-being by fulfilling the basic principles for sustainable development. However, there are several components that need to be mentioned in it to have a broader panorama of smart cities. Before delving into some of these components, it's crucial to acknowledge that various cities have distinct approaches to each dimension, as previously mentioned. However, in general, the basic components are as follows:

Figure 13. Smart city components



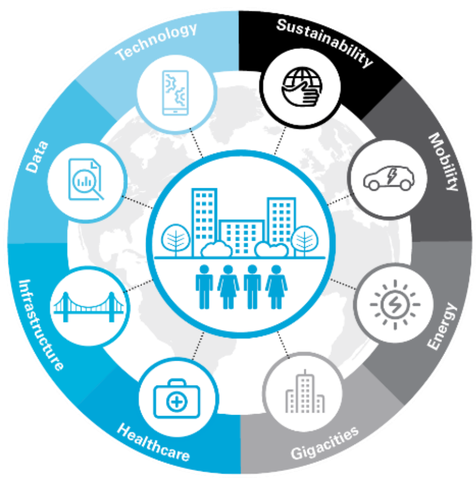
Note. Data source: (Arroub et al., 2016; Winkowska et al., 2019)

Smart economy is a concept that can have several interpretations, where, according to Winkowska (2019), it can be measured based on entrepreneurship, investment, productivity, international collaborations, and market adaptability. Pursuing economic models that are focused on sustainability, resource management, innovation, the application of AI, the construction of modern infrastructure, the digitalization of industries, and collaborations between industry and academia leads to the development of a smart economy (Ristvej et al., 2020).

Smart governance: This component emphasizes critical issues in decision-making, such as transparency, access to information, services that respond to the needs and demands of the community, etc. But this approach can face a series of challenges that, according to Ooms (2020), can be successfully overcome if there is an organized form of participation for all stakeholders involved, determined by the relevant institutions to create intelligent solutions and plans.

Smart infrastructure & buildings: In a classic context, a city's infrastructure encompasses elements such as buildings, roads, and bridges; conversely, in the context of a smart city, infrastructure includes any physical, electrical, and digital devices essential for the city's intelligent development. But infrastructure developed based on technology, sensors, etc. creates the opportunity to optimize energy use, allows for data-based decision-making, reduces economic costs, identifies risks over time, and, above all, leads to efficient and sustainable solutions. Thus, infrastructure development is considered one of the most important parts in the creation of smart cities.

Figure 14. Smart infrastructure



Note. Data source: (White & Case LLP, 2022)

Smart Transportation: Smart transportation is the component on which most smart city initiatives focus and pertains to the integration of technology in the transport infrastructure to improve mobility, reduce traffic, and increase environmental sustainability (Anwar & Oakil, 2024). The technologies incorporated into this system are mainly AI mechanisms for certain automated tasks, Big Data for processing the generated data, IoT for sensors, etc. The importance of smart transportation systems is most prominent in urban areas where transport networks are insufficient, hindering the economic potential and the overall dynamics of the city.

Smart healthcare & living: Smart living is a concept that contributes to an increased understanding of how society is changing through technological advancements in its favor (Anthony Jnr, 2021).

IoT and AI technologies have facilitated medical services by enabling timely disease detection and real-time health monitoring through advanced digital systems. Furthermore, this component also focuses on air quality control through IoT sensors, noise monitoring, lighting, and living conditions, which support affordability, inclusiveness, and overall well-being in the city (Othman et al., 2024).

Smart environment: A smart environment uses technological systems to manage, monitor, and improve environmental concerns (Narayana et al., 2024). These technological systems encompass sensors, IoT devices, and the analysis of data derived from these sensors and devices via machine learning and artificial intelligence to monitor water and air quality, manage waste, and regulate energy use, among other applications. Such platforms contribute to better and more sustainable living conditions by ensuring the use of natural resources in a more ecologically sustainable manner.

Smart citizen: This component is different from the others because it focuses mainly on knowledge, information exchange, and citizens' capacity to benefit from the potential offered by technology (Ristvej et al., 2020). The smartness of a city's residents can be determined by various factors, such as their socioeconomic level, cultural diversity, the qualifications they possess, their mindset, and their viewpoint on reality and the future. According to the Organization for Economic Co-operation and Development (OECD) report (2020), smart cities that take real steps to prioritize citizens can serve as drivers of social transformation by promoting equality and inclusion and a higher quality of life.

2.4.3 Smart city challenges from a citizen perspective

It is evident that digitalization has made urban life smarter by enabling automation through software and advanced technological systems. However, technology, being a fundamental part of the functioning of almost all aspects of citizens' daily lives, brings a series of challenges that must be taken into account before being properly addressed. Thus, the table below lists the threats that may be associated with each of the components of a smart city, leaving behind two main aspects: citizen adoption and the dehumanization of urban life through processes automation.

Table 2. Smart city challenges

Smart city component	Challenges	References
	- Market concentration through platform monopolies	(Ande et al., 2020; Apostol et al., 2015; Yigitcanlar et al., 2018)

Smart economy	- Regulatory gaps - Customer data privacy - Infrastructure cost - Environmental impact etc.	
Smart governance	- Data security and privacy - Stakeholders' ability to cooperate and leadership support - Coordination between private and public sectors	(Arroub et al., 2016; Coelho et al., 2021; World Economic Forum, 2021)
Smart mobility	- Data security and privacy - Energy consumption efficiency	(Paiva et al., 2021; Xie et al., 2019)
Smart living	- Data security and privacy	(Elahi et al., 2019; Yigitcanlar et al., 2018)
Smart environment	- Technical risks - Data Privacy & Ethics	(Giffinger et al., 2007; Xie et al., 2019)
Smart citizen	- Data privacy	(Allam & Dhunny, 2019; Radu, 2020)

Citizen adoption refers to the acceptance of these advances. The acceptance means that citizens agree to adapt and use technological systems, but this issue often faces major problems, especially in developing countries. First, for citizens to decide whether to embrace the offered digital services or systems, it is crucial to understand these systems purpose, the advantages and benefits they provide, and how secure are the data provided. Conversely, if the information is incomplete or the method used to deliver instructions is ineffective, citizens will not adopt these digital services. Secondly, it is evident that the lack of necessary infrastructure and socio-economic status are factors that directly affect citizen adoption of smart systems; therefore, investment in capacity building and the development of technological infrastructure should be viewed with interest to avoid the digital divide as much as possible. An important factor in this matter is the motivation of citizens to be active in the use of smart systems by developing dedicated information strategies about their benefits in improving their common social wellbeing. This can be considered a critical point because if citizens do not have the interest or desire to embrace the changes in the environment provided, a smart city cannot be sustainable.

In addition, one of the biggest concerns people have today regarding the implementation of smart cities is the dehumanization of urban life. By placing technology at the core of every process, people are losing face to face communication with each other, and almost all services are performed through automatic systems that use AI. Since decisions are made by algorithms and not by people, social context often remains underestimated, making people feel excluded. This problem is more common in services that require negotiation or dialogue, especially for the elderly, people with disabilities, or people who do not know how to use those systems and cannot perform their services. This phenomenon creates a panorama of social dehumanization, which is perceived by citizens as a centralized control of information without urban solidarity.

To refer back to the table above, it is illustrated that numerous studies have concluded that the greatest risks involve privacy and data security. This challenge prompts the development of a series of strategies and projects at a global level to address capacity building in order to deal with digital rights and ethics of technology. For this reason, based on the United Nations report (2024), about 71% of countries in the world have adopted data security laws but have encountered many difficulties in implementing them, and despite this, the interpretation of these laws is heterogeneous at the global level. This makes the cybersecurity issue even more difficult to create fixed rules for all countries in order to strengthen existing laws and promote equitable data sharing practices. However, the level of complexity and challenges changes over time due to technological advancement and dynamic urban processes. Consequently, continuous monitoring of these smart systems is one of the main pillars where the smart city concept must be focused to ensure sustainability.

2.5 Summary

Based on foundational theories and models discussed in this chapter, it is asserted that participation in urban planning has been considered a very critical issue since earlier periods. Initially, people viewed this notion through the lens of social empowerment and the promotion of self-determination, but they never separated it from the political aspect. This is because participation in decision-making processes is itself a complex issue closely linked to the political aspect of planning. However, this process, apart from the political aspect, consists of integrating the historical, cultural and social elements that make up the urban space, with the aim of increasing a sense of belonging and identification. Preserving the diversity that makes up urban spaces by taking into account the opinions of citizens who are the most affected by changes is closely related to the strongest point of Arnstein's model (1969), which provides a methodology for measuring the level of power that citizens have in decision-making. Social sustainability, one of the main components of sustainability discussed in the previous sections, has developed at the slowest pace. This issue may have come about as a result of many factors, but the most important and related to the focus of this research is the underestimation of the voice of citizens in policies that directly impact their daily lives. There are different forms of participation, but the success of their implementation hardly depends on the objectives of these initiatives and the planning model used. This chapter, supported by numerous studies, demonstrates that implementing a hybrid planning model—combining top-down approaches with bottom-up initiatives within a structured framework defining citizens' roles in decision-making—successfully advances a country's economic, political, and social development. The sections above have discussed the planning paradigms of Singapore and Copenhagen from precisely this perspective. However, based on this discussion, it is important to highlight how technology influences the development of a comprehensive and effective planning model that incorporates the fundamental aspects of urban sustainability. In summary, it is worth mentioning that all countries in the world today are attempting to implement smart city initiatives in their own unique ways, influenced by economic, social, political, and particularly historical factors that shape these strategies; however, it is crucial to monitor these initiatives to ensure the preservation of the human aspect.

CHAPTER 3 - Digital Participatory Planning and AI

"All the cities of the world are going to expand. We need to have a better understanding of what makes good urban habitat for home sapiens. We have an obligation to make the new places more livable, more sustainable, more healthy. We have the tools."(Stubbs, 2020)

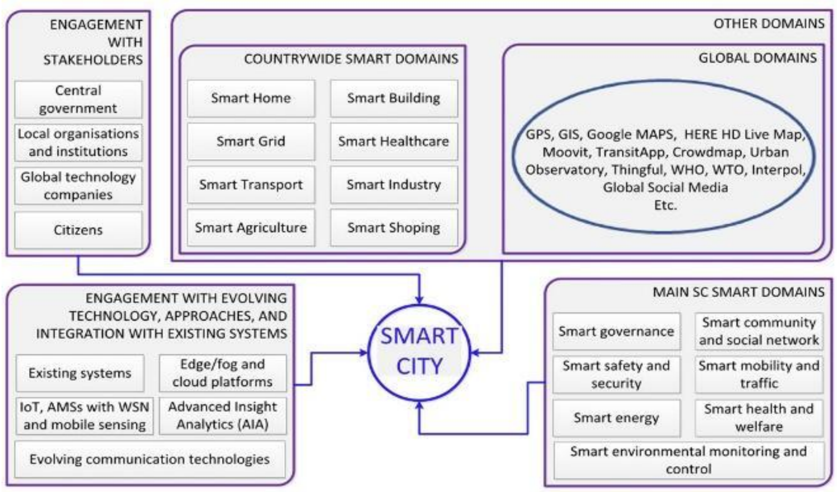
After building the conceptual and theoretical framework for citizen participation in urban planning, it is important to examine the major shift that these processes have undergone due to digital transformation and the global challenges that almost all countries have faced. In this context, the chapter presents the initiatives undertaken to address these challenges, the technologies most commonly used in citizen involvement processes, the role of social media in citizen engagement and the impact of the COVID-19 pandemic on the development of these policies and urban practices. Being a period that left its mark on the way citizens, institutions, and communities interacted with each other and with urban spaces, it was considered appropriate to treat it as a separate issue by analyzing the strategies that proved successful, as well as the challenges that emerged, especially in the context of bottom-up planning, which became significantly more difficult during the period of physical distancing and social restrictions. To establish a clear connection with the Albanian context and facilitate the transition to empirical chapters that address ML techniques and case studies, this chapter briefly discusses the urban development of Tirana after the 1990s, the concepts of participatory planning within the framework of the Co-PLAN organization's initiatives, and the current practices for planning and approving urban projects. This analysis is essential to further argue the importance of the proposed methodology and the value that this topic brings to the Albanian reality, where participatory processes often remain fragmented or formal, directly affecting the quality of urban decision-making.

3.1 Smart urban planning through technology

The process of digitalization has been part of urban planning for more than three decades, but only after 2010 did it become widespread worldwide. In planning, the digital transformation began with the use of much-improved software such as 2D and 3D simulations with additional and advanced functionalities (Christmann & Schinagl, 2023). Various studies have shown that to accommodate this new way of working in urban planning, the so-called Planning Information Systems (PLIS) were created, which enabled the collection of spatial data, digital models, and various detailed maps.

As mentioned in the previous chapter, the need for smart cities has marked a major turning point in the way urban planning is adapting to new technologies to create more manageable, efficient, and sustainable urban environments (Komninos, 2011). However, the primary issue resides in the fact that urbanization deteriorates the imbalance that exists between population needs and development in urban spaces (Jacques et al., 2024). This is the reason why one key aspect of smart city development is its ability to address the challenges associated with rapid urbanization.

Figure 15. Smart city dimensions



Note. Data source: (Adio et al., 2024)

As indicated in the discussion about smart city, is understandable that technology plays a fundamental role in shaping urban planning through new innovative solutions that address challenges to traditional methods of planning. Therefore, over the last decade, the application of digital technologies in urban planning and management has received greater attention. For example, during Covid-19, the use of cloud computing technology became widespread, which, although it had been developed for some time, was not widely known for the significant advantages it offered in storing data securely (Kim et al., 2021). Furthermore, it is important to mention the Computer-Aided Design (CAD) application, which revolutionized urban design through the sophisticated functionalities it offered for precise technical drawings, the design of buildings and urban spaces, etc. Additionally, 3D visualizations using the Virtual City Models (VCM) system allowed for testing different scenarios through simulations like traffic patterns, assessing the environmental effects of planned projects, and planning the best responses for emergencies or disasters. Consequently, the use of IoT, AI, and digital twins represents a necessity in urban planning practices, which must manage and, above all, understand the generated data (Lin & Benneker, 2022).

In addition, this situation has also created a need for relevant institutions to create opportunities for training and educating future generations of urban planners in these categories. The use of these advanced systems increases the ability of various agencies and institutions to process a staggering amount of data. The use of the various tools provided helps to increase the understanding of spatial dynamics, support the decision-making process through the generation of knowledge and analysis with high accuracy, and deepen relationships between interested parties.

However, studies indicate that many urban services are still performed manually based on traditional planning methods, resulting in often inaccurate results or inadequate plans (Daniel & Pettit, 2021). To build sustainable and democratic cities by prioritizing the needs of their inhabitants, it is crucial that society as a whole adapts to the digital transformation, which requires not only a redesign of urban planning practices and investments in digital infrastructure and governance but also a cultural transformation. Only with this approach can cities establish inclusive and sustainable urban environments for the future.

3.1.1 Smart planning practices for addressing global urban challenges

While digital transformation is expected to bring major benefits in environmental protection and land use through data-driven decision-making, it is also making an entirely different determination in the overall planning culture. Traditional methods have been replaced by digital tools and software that are based on data and enable more transparent, comprehensive and, with a much higher probability, easily adaptable planning to the demands and needs of citizens. As mentioned, this process of change has been going on for a long time in urban planning since CAD and Geographical Information System (GIS) were first introduced in the 1990s (Batty, 2009). Urban complexity is an escalating concern, exacerbated by pandemics, climate change-induced natural disasters, international conflicts, and socio-economic disparities. Addressing this challenge through effective urban planning and technology is essential for fostering innovation and ensuring sustainability for future generations.

Urbanization and population growth

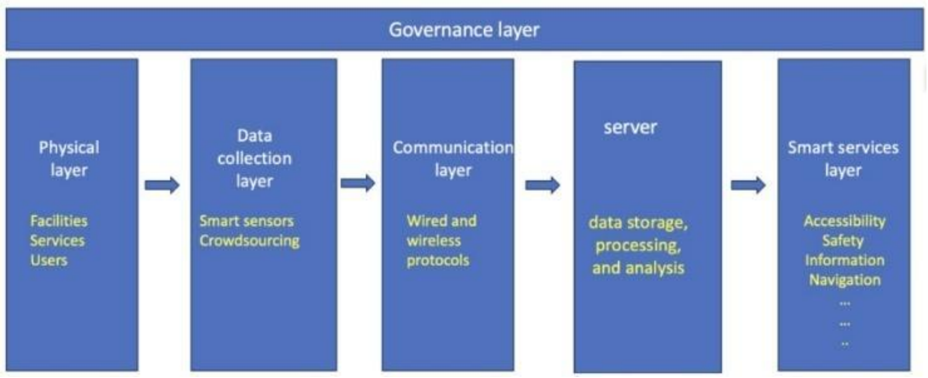
In previous discussions, the global challenge of urbanization has been mentioned several times, being felt as a risk not only currently in managing the ever-increasing problems and complexity but also as an even more difficult challenge in the future based on the UN report (2024). That report emphasizes that 68% of the world's population is expected to live in cities by 2050, raising this issue as an alarm that requires immediate attention, not only from the relevant authorities but also from all people. These threats and problems are even greater in developing countries like Albania, but it is worth noting that even highly economically developed countries on the path to smart cities are facing new situations every day and making slow progress in addressing them. In this context, all actors involved are trying to overcome the created obstacles, but urban planners are among the most affected. As previously noted, in these conditions it is understandable that traditional planning methods are no longer sufficient to provide solutions to this complex system created. Technology, especially AI, has brought a series of benefits and conveniences in this aspect, especially in the creation of a data-driven model in decision-making. Thus, many institutional units in cities are using AI tools, such as ML algorithms, to generate in-depth knowledge in different systems, enabling decisions to be made effectively and at the right time (He & Chen, 2024).

Furthermore, the GIS systems (described in more detail in the following sections) have simplified the work of planners through the digitization of maps and advanced modelling to better understand various infrastructural, geographic, and environmental parameters. In addition to GIS, various other intelligent practices are implemented to address the issues of growing urbanization, including smart mobility, which is facilitated by the real-time monitoring of public transport networks and their management through modern IoT sensors. These are just some of the practices used to address this challenge; however, it is worth noting that there is a wider range of other tools, many of which are still under development but which have considerable potential to overcome any situation if managed properly.

Social equity and inclusivity in urban spaces

In modern urban planning, technological solutions have made it possible to promote social justice and inclusion, and a series of approaches have been tested and used for this purpose. Public spaces have been considered essential for mental and physical health, inclusion, building community relationships, citizen engagement, and economic dynamism (WHO, 2021). The UN 2030 Agenda for Sustainable Development emphasized the importance of creating inclusive public spaces, specifically for women, children, and people with disabilities (United Nations Department of Economic and Social Affairs, 2015). For this, different approaches have been proposed around the world, and urban efforts to prioritize the equitable distribution of urban spaces should have the primary focus on the different needs of neighborhoods and residents (Itair et al., 2023; Wolch et al., 2014). Figure 16 shows the layers of a smart public space.

Figure 16. Smart public space layers



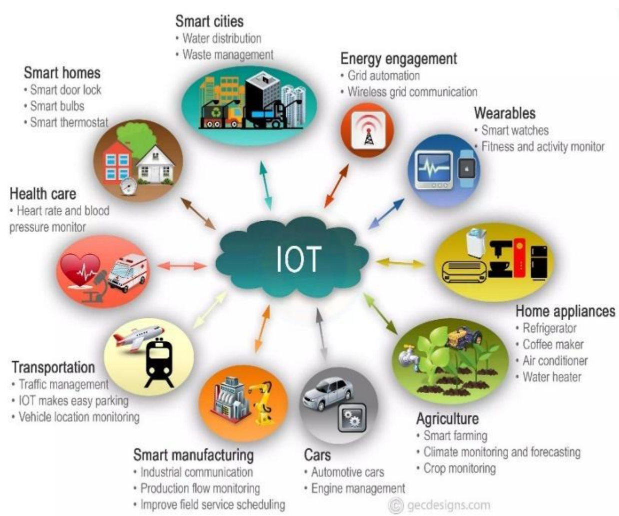
Note. Data source: (Itair et al., 2023)

In this context, technology plays a fundamental role in facilitating participatory planning procedures, identifying spatial inequalities, and assessing whether resource allocation addresses the real needs of communities (Marshall et al., 2024; Rocco et al., 2022). These resources can include digital tools like software for advanced location analysis and predictions, platforms that tackle various city issues, and GIS platforms that help understand the unfair distribution and access to public services, infrastructure, and green spaces. Moreover, to facilitate citizen involvement in the planning process, there can be reference platforms that gather citizen feedback, various systems that use AI to simulate urban scenarios, and digital twin technology that aids decision-makers and stakeholders in comprehending and devising intelligent solutions to address local requirements.

3.1.2 Key technologies for smart urban planning

Smart cities aim to improve the quality of urban life through the implementation of technology. As countries around the world aim to move towards this path, it becomes important to explore some key technologies that will impact their development. The integration of individuals, sensors, and advanced systems into urban surroundings results in interconnected cities functioning as a unified system (Ali et al., 2023). The information supplied by these systems facilitates secure decision-making in the administration of infrastructure, transportation, energy, public safety, and environmental conservation (Alhalafi & Veeraraghavan, 2023). In this context, several technologies have been developed that have served as essential components in smart planning strategies, such as GIS, big data, the IoT, digital twins, urban simulation models, etc. These technologies are briefly described below.

Figure 17. Key technologies for urban planning

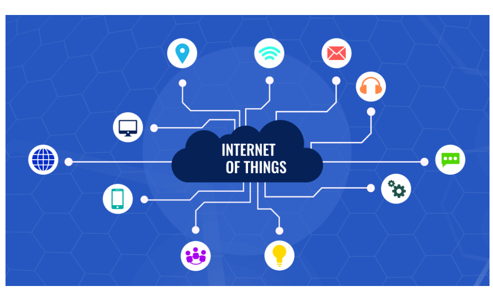


Note. Data source: (BotPenguin, 2025)

IoT

IoT is a network of interconnected devices that collect, transmit and exchange data over the internet without human intervention. Devices in IoT can be of various types, such as sensors, buildings, machines, etc. This network of devices and sensors connected serves as a fundamental instrument in the development of smart cities (Ugwoke et al., 2024). Figure 18 illustrates some of the most important IoT applications.

Figure 18. IoT applications



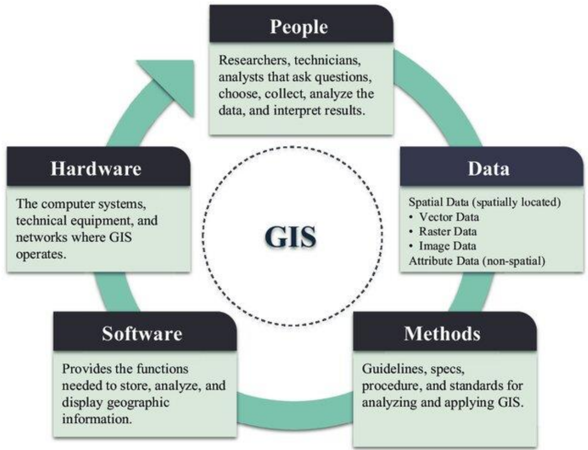
Note. Data source: (WeeTech Solution, 2018)

In this context, sensors and IoT devices integrated into public spaces, transportation networks, waste management, energy usage, and other essential systems are pivotal in monitoring and regulating these vital components of the urban environment (Simionescu & and Strielkowski, 2025). The collected data is stored and processed through advanced technologies, such as big data, analyzed through ML algorithms, and generated reports with high accuracy in real time, enabling precise monitoring and management of the aforementioned systems. McKinsey & Company stated that IoT solutions in smart cities have the potential to reduce energy consumption and traffic by up to 30% (EMB, 2024). Thus, by integrating IoT technology into urban planning, a more sustainable, higher-quality, and inclusive urban future can be created (Huda et al., 2024).

GIS

GIS is an intelligent tool that enables the storage, management, processing and generation of spatial data. It is a computer-based tool that is widely used in urban planning for land use planning, the design of various ecosystems, territorial planning, infrastructure and transportation planning, real estate valuation, etc. Through the analysis of the data it provides, it also visualizes it in the form of maps, graphs, or statistical reports, which are easily readable by the users of the system (Geoapify, 2023). Since the data, before visualization, is processed and analyzed by GIS functionality, it allows urban planners to make decisions based on these results through the analysis of land use patterns, an assessment of environmental impacts, the identification of spatial inequalities, among others. Consequently, GIS facilitates decision-making by formulating several action possibilities within geographic space through comprehensive data analysis tailored to the given context (Eldrandaly, 2011). The context can vary from socio-economic conditions, infrastructure, land use, population distribution in the territory, etc. The integration of many contexts inherent in a geographical place facilitates a comprehensive analysis to comprehend the interaction established between human activities and the surrounding environment. Figure 19 illustrates the main components of GIS.

Figure 19. GIS components



Note. Data source: (Costantini & Thompson, 2023)

According to Xhafa (2024), GIS has transformed urban planning by:

- Efficiently extracting spatial data from various sources through digital tools and automated processes
- Effective decision-making through the interpretation of social, environmental, and spatial dynamics using thematic maps, spatial models, and graphical visualizations.
- Using data from the different contexts that make up an urban environment, serving to design strategies that are compatible with the setting.
- Enhancing public comprehension of land utilization, resource allocation, and the impact of specific decisions on urban living. This approach fosters critical thinking among community members, enabling their effective participation in local urban planning.

Big data

While urbanization is a growing trend worldwide, big data technology has emerged as a necessity to process the massive data that results from these major changes in population, settlements, infrastructure, and every other aspect of urban environments (Pan et al., 2016). These urban data relate to the state of various elements such as buildings, roads, the environment, businesses, the economy, products, logistics, culture, education, and the population as a whole. Big data is a term that refers to a quantity of data that is naturally generated through urban activities. Given the staggering amount of data produced every day, the power offered by the technologies behind the term big data, such as data warehouses for storing, managing, and processing it, ML algorithms, etc., is definitely necessary. This extensive data can be assimilated into advanced systems, like AI tools, disseminated, and analyzed, and concealed patterns can be unveiled through ML, facilitating decision-making based on these analyses and forecasts, minimizing the operational costs of urban systems, and, most importantly, fostering the intelligent development of cities. According to Thakuriah (2015), urban informatics in combination with big data has a major impact in several areas, such as:

- Improved strategies for dynamic resource management
- Effective strategies for citizen participation
- Innovation in urban planning and management
- Creation of in-depth knowledge about urban processes and models

Many cities have successfully created mechanisms to take advantage of this potential, but others still have great difficulty adapting to this innovation. And this shortcoming is most noticeable in developing countries (Shehu, Lezzerini, 2024). These challenges relate to the integration of these technologies into existing systems; the lack of appropriate digital infrastructure; inequalities in access; and data security. Furthermore, the lack of big data and especially cybersecurity experts makes the implementation of this technology even more challenging.

Figure 20. Big Data technology

Note. Data source: (Prasad, n.d.)

The ability to apply big data is not universal, and therefore many cities do not use these technologies appropriately due to a lack of knowledge and training (Joshi, 2024). However, if these challenges are addressed strategically, according to Ogunkan (2025), big data can offer a series of opportunities and advantages as follows:

- Resource efficiency and energy management: Through predictive analytics, big data helps to better allocate and manage resources and reduce energy consumption (Yusuf et al., 2024).
- Pollution monitoring: Using IoT sensors to monitor air and water quality in real-time, along with big data technology for analysis, allows for quick detection of problems and the ability to take preventive actions based on precise predictions from big data analytics (Lei, 2024).
- Improved public services and accessibility: Real-time data allows cities to respond to the genuine needs of citizens, contributing to an equitable social life and a higher quality of coexistence.
- Effective transportation systems: The analysis of traffic and public transport models enables the optimization of transport networks.
- Community participation: Data-driven governance can lead to the creation of policies and strategies that are more context-sensitive by strengthening the relationship between citizens and governing institutions.

Digital twin

The concept of a digital twin has emerged as a powerful tool, especially in urban environments, transforming the way various physical systems operate and are managed. A digital twin is a system that reflects the virtual model of physical systems, increasing the understanding of the functioning and management of various urban ecosystems. This technology offers advanced functionalities for incorporation within various system components, easily identifying problems and weak points of the system and, above all, making predictions about its performance. Similarly, it can be described as a simulation model that collects data from the surrounding environment and initiates actions on physical devices (Al-Sehrawy et al., 2021). According to Durão (2018), a model that is considered a digital twin must meet several criteria, such as:

- The ability to adapt and connect accurately to the system's physical model is crucial. This ability ensures that the digital model is reliable for performing simulations and performing analysis and predictions;
- The virtual model can expand through the incorporation of different data sources, new functional modules, etc. This quality makes the virtual model easily adaptable to the growing complexity of the system;

- The ability to easily interact and communicate between different data models, ensuring that the digital model can function within different digital ecosystems through the integration of other systems such as IoT, GIS, etc.;
- Scalability, which refers to the model's ability to work effectively with varying amounts of data and the ability to represent systems of varying levels of complexity, from a single sensor to an entire city;

In addition, digital twin is characterized as a model that is continually updated to integrate with a system that accurately depicts and illustrates the current status of the process comprising that system (Attaran & Celik, 2023). So, the main concept on which the digital twin is based is the real-time synchronization between the physical and digital models.

Figure 21 illustrates some of the advantages offered by digital twins according to Shahat's study (Shahat et al., 2021).

- The potential to visualize transforms complex systems into easily readable systems, enabling real-time monitoring, simulation of various processes, prediction of changes in the physical environment, etc.
- Managing different types of data from different sources makes this functionality one of the main features of this technology. Situational awareness achieved by systematic monitoring of the system or physical surroundings enables real-time detection and even prediction of system flaws or malfunctions. This functionality enables the digital twin to produce real-time insights regarding the system's condition (Castelli et al., 2019).
- The integration of multiple data sources and different stakeholders inside a unified environment renders the digital twin a unique system.
- Developing plans and performing predictive analyses on different situations makes digital twins an indispensable technology for the development of smart cities.

  Based on this description of the digital twin, it can be concluded that it is a highly compelling technology that primarily enables and promotes a data-driven decision-making process, while offering a wide range of advantages for urban planning and related disciplines.

Figure 21. Digital Twin potentials in smart city

Note. Data source: (Shahat et al., 2021)

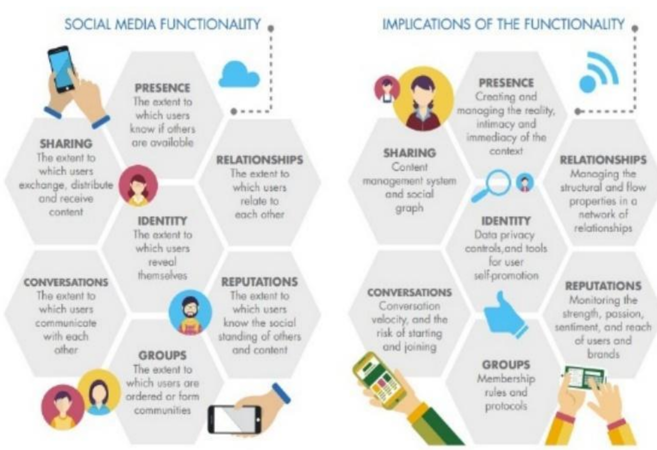
3.2 Social media for participatory urban planning

Social networks are a compelling tool today, with a large number and variety of users. These platforms have provided citizens with parallel opportunities to be informed, to be active, and to be support in important processes that directly affect their lives. In addition, this channel of communication has enabled increased interaction between institutions and citizens. Thus, citizens feel free to express their opinions through social networks, creating opportunities for collecting these opinions in real time and creating a true dialogue between decision-making institutions and citizens. In this way, transparency towards the community can be increased, and an accurate assessment of citizen perception towards various urban issues can be achieved.

The individuals who have seen the most benefits are activist groups who find it much easier to share information, increasing the impact of their positions, and to form virtual community groups for support simply by implementing hashtags and keywords that make them more discoverable. Social media platforms like Facebook, Twitter, LinkedIn, Instagram, and YouTube facilitate the sharing of information and calls to action due to their concise structure. The Reddit platform can also be mentioned here, as it provides opportunities for discussions and knowledge sharing among various professionals, activists, and scientific researchers. This is a more specific platform than the others, since the focus on it is not on creating a personal network but on sharing knowledge between communities created through forums structured around certain topics and with certain rules. Thus, Reddit is primarily used by citizens seeking information or technical assistance in specific fields, as well as those interested in various topics like hobbies and environmental protection, which often involve lengthy discussions.

By combining text, video, and geospatial data, citizens are more motivated to participate because they can visualize the information more clearly. In this way, in terms of managing urban complexity in cities, systems can be built that serve to monitor and manage traffic, air pollution, natural disasters. Although these communication channels are virtual, they should not be limited only to the dissemination of information, but should be two-way interactive systems. Meanwhile, from the above discussion, it can be asserted that these virtual communication systems play an essential role in promoting a more transparent and inclusive decision-making process in the city.

Figure 22. Social media functionality and implications



Note. Data source: (CIVITAS WIKI, 2016)

The advantages that their integration into urban planning can bring can be summarized as follows:

- Planners can increase transparency in decision-making processes by using tools such as web scraping, online polls, and interactive mapping tools to cultivate a sense of inclusion among community members, which leads to the creation of more responsive policies (Hussain et al., 2024).

- More accurate determination of urban priorities and identification of problems in real time. Through the analysis of social media data with ML techniques, urban issues that are perceived most critically by the community, such as traffic, housing, transportation, etc., can be identified. Furthermore, issues that are problematic can be discovered, allowing planners and institutions to take timely measures.
- Broader public involvement. Due to their widespread use and the opportunity that offer to overcome the barriers of traditional participation methods, social media platforms expand the audience base and enhance public awareness, thereby creating opportunities for more active participation, including by marginalized groups (Lin & Kant, 2021).
- The use of spatial data helps planners and institutions to conduct more detailed analyses based on the location of citizens.
- Increased legitimacy of urban projects and policies. When institutional initiatives on urban issues incorporate citizens' opinions, ensuring full transparency regarding the process and clarifying the role those opinions play in decision-making, credibility and acceptability within the community increase.

To benefit from all these advantages, it is not enough to simply create some participatory models through online platforms, but the relevant institutions must also create mechanisms that demonstrate the feedback received from the analysis of this data. Moreover, it has become necessary to have an institutionalized form of citizen participation where clear directives are given for participatory formats (in this case, social media), the level of consideration of the feedback received, the strategies used to maintain the authenticity of information, the data retention policies undertaken, etc. So, the opinions, ideas, and experiences expressed by citizens should be managed and processed according to a strategy defined in a framework by the relevant institutions, depending on the level of citizen involvement in the decision-making process and the issue at hand. In this way, institutions can genuinely engage in collaboration with citizens, offering solutions that address their actual needs and demands while integrating the opinions voiced on social media. As a result, citizens, who are more informed and feel actively involved, are more likely to respond positively to institutional policies and projects, demonstrating a greater willingness to cooperate rather than consistently opposing governing bodies. Social media offers these opportunities for transparency, freedom, and diversity, so it remains to be seen how cities will approach this completely new, challenging, but also promising methodology.

3.2.1 Shortcomings and reflections on social media engagement

Meanwhile, despite the numerous advantages, there are also a series of challenges that can be associated with their use in shaping urban planning policies. Thus, one of the biggest challenges has to do with the authenticity and reliability of the information distributed. The dissemination of information on social media places planners in charge of their management, but since these platforms produce a staggering amount of data every day, expertise is needed in their processing. Thus, given the rapid evolution that urban life is undergoing today, it has become a necessity for planners to develop their capacities not only in aspects related to their field but also with a focus on technology. This highlights the need to build the necessary capacities to deal with the data provided, but this does not only require experts in the field of AI but also requires planners and experts in other fields to invest in their skills. The data collected every day offers extraordinary potential for the better functioning of the complex urban system created; therefore, it remains in the hands of planners to focus their objectives on long-term sustainability, certainly through citizen-centered initiatives and strategies to which social media can contribute in an indisputable way.

However, some of the challenges associated with their use in urban management are the same as those associated with the smart city concept, such as data privacy and dehumanization of processes. These two threats have been discussed at length in the previous sections, so there is no need to expand on them further. But since the research is focused on citizen-centered urban planning through social media, it is worth mentioning the challenge that can be encountered in assessing citizens' opinions/perceptions only from their messages and comments through verbal communication. According to Zhang (2024), non-verbal communication is important to clarify misunderstandings, explain impressions, etc.

A phenomenon that is most noticeable on social media is the dominance of groups that are considered 'elite' in society (Ouyang & Bai, 2025). These groups usually include professionals, academics, and public figures who have influence on public opinion. It often happens that these groups direct public opinion to increase their audience or for personal interests, which makes the analysis of such data unrepresentative of urban reality. The expression of opinions online, especially on sensitive urban issues, can also be influenced by the opinions of the majority of citizens, creating a mentality that underestimates the diversity and authenticity of public participation. Another nuance of using social networks for public participation, particularly in everyday urban management, is that the polarization and extremism in comments often lead to the analysis overlooking the most profound and valuable insights. This is a very sensitive issue and it mainly has to do with the freedom that citizens feel on these platforms to express their opinions. This aspect is certainly considered a benefit of them that leads to the collection of real data, leading to more responsive decisions being data-driven. But on the other hand, it can also be considered a problem because it happens that the opinions expressed are excessively emotionally polarized, which is likely to have an effect and rapidly spread in public opinion.

As mentioned in the end of the previous section, to ensure that social media is effectively integrated into urban management and planning, it must be implemented within a structured framework designed to preserve the authenticity of information and diversity among participants, while also respecting citizens' freedom in its use. For the process itself to be genuine, this element is especially important.

3.2.2 Illustrative cases of social media use towards participatory urban planning

Social media has often been used by decision-making institutions and urban planning experts to understand public opinion, disseminate information, and support participation in various planning processes. This is because traditional methods of engagement mainly have low participation due to their inability to be present in a place at a specific time or because they feel unmotivated or are part of marginalized groups. However, being active through digital instruments can overcome these limitations by significantly increasing the level and quality of participation. The following cases, sourced from various researchers, demonstrate the potential of these instruments in facilitating participatory planning. However, it is worth noting that in most cases, full participation is lacking because citizens participate without a clear objective or awareness, as their data are mainly extracted passively through online platforms. These data generated naturally by citizens may contribute to various studies conducted by urban planners and institutions, but there is no transparent mechanism for meaningful influence on decision-making processes. Subsequently, mainly the data generated by citizens while using social networks is part of various studies by urban planners, but without a transparent mechanism for real influence on decision-making processes.

In case studies from the Netherlands, Lin and Kant (2021) combined interviews, government-portal data, and web-scraped social-media content to evaluate the extent to which institutional and political contexts condition the effectiveness of social media for civic participation. To illustrate this, they examined two case studies that employed different participation methods: the first case utilized only online participation, while the second integrated online methods with traditional approaches such as public consultations, community meetings etc. Thus, it was concluded that platforms do indeed offer benefits in terms of transparency and inclusiveness, but the main actors remain institutions. In short, it is considered a top-down approach; for this reason, it is argued that a combination of virtual and traditional forms of participation should be found to ensure a fair and efficient model for all parties. To return to the essence of this research, it can be said that it is essential that the use of social media and other online means of participation be orientated and transparent so that citizens are aware that their interaction on social media constitutes participation. Therefore, despite all the benefits of this approach, a well-structured integration is necessary between dynamic ‘virtual’ methods and traditional methods to maximize collective intelligence for cities to promote high social well-being. Only through this integration can true participation be achieved. On the other hand, there are many researchers who have investigated how opinions expressed on social media can serve to identify citizens' perceptions of various urban issues based on a simulated environment. For example, users often comment on their experiences while trying to build or manage "virtual" cities in video games, including all their components, like infrastructure and the environment. Thus, Qiu (2024), in his study, collected these comments and perceptions from the Reddit platform to understand how citizens perceive urban planning, their primary concerns regarding it based on real experiences and ideas for solving these problems. Through sentiment analysis and content analysis of the collected data, various priorities and issues were identified, highlighting both positive and negative emotions related to the urban planning process asserting that such platforms offer great potential for participatory planning. The approach used in this study highlights the fact that, through this 'informal' interactive way of obtaining data, it becomes possible to increase understanding of the nature of planning practices created for different social, cultural, etc. settings. These examples collectively indicate that data collected from citizens' personal experiences and freely expressed feelings provide a diverse range of knowledge that can facilitate real analyses aimed at promoting fairer decisions in the social and urban context.

So far, it was asserted that social media has the potential to remove the barriers created by traditional media to citizen participation in decision-making processes. The focus is primarily on groups excluded from this process due to various economic, social, and cultural factors. However, it is important to consider that in developing countries, rural areas often face challenges related to digital infrastructure and internet access, as well as a significant lack of awareness about the benefits these platforms can offer. This could also be a consequence of the immigration of young people to larger cities, and the elderly remain isolated in rural areas. Such isolation is a major challenge that many countries in the world are facing, especially Albania, where such a phenomenon is being observed more and more every day. Hussain (2024) specifically took an isolated mountainous area into consideration to see how the embrace of social networks would affect inclusion in urban planning processes, specifically in land management practices and green spaces. Unlike other approaches that focus mainly on urban areas, this case is significant because it involves a region that struggles with information dissemination due to its geographical population distribution, making it an important contribution to treat in this research. However, despite these challenges, the qualitative analysis indicated that social media facilitates information dissemination and interaction among stakeholders, strengthens civic engagement by cultivating a sense of shared responsibility, and most importantly enhances community influence over decision-making. In this case, it can be said that a substantial form of participation was achieved because citizens was aware that their opinions will be part of a process, although it was a case study and not a step taken by the relevant institutions. The results achieved underscore once again the importance of harnessing the potential of these tools, which the majority of the population uses. Numerous studies consider social media participation an informal form that has, in many cases, influenced various urban policies and projects. He (2024) used this approach in a case study in China. He developed a mixed method that included social media, web scraping, interviews and field observations to reach the most accurate conclusions. The aim was to understand how the power dynamics of the main parties involved, such as civil society, activists, citizens, and institutions, changed in the planning process. The "Enning Road Regeneration" project, which proposed a complete reconstruction of the area, was cancelled due to the strong reaction it provoked in digital spaces through debates and online forums organized by civil society organisations, activists, and citizens. This case demonstrates that social media, although still considered an informal form of participation, has the capacity to really influence decision-making processes of public importance.

The same methodology was used in the case of the Bell and Drum Tower project in Beijing, where it was observed that social networks played different roles at different stages of project planning (He et al., 2024). Public feedback on social networks influenced planning decisions made by relevant institutions in both of these case studies. Furthermore, these studies argue that several different forms of empowerment exist, including: first, the involved actors become more influential by creating communities (such as those of experts); second, they control the flow of information by occasionally serving as intermediaries between citizens, journalists, institutions, organisations, and others; third, they expand the community by adding citizens who are influential themselves as activists, decision-makers, entrepreneurs etc. From these forms of empowerment, it is noted that even within these bottom-up initiatives, a hierarchical role structure is created where the most active people who are the initiators become the main voice. This also constitutes one of the main challenges of this participatory method, which in the previous section was described as being dominated by actors considered to be the “elite” of society. However, despite the unequal forms of empowerment that can be created within social networks, institutions and urban planners should seriously consider the opinions expressed in these online systems. Moreover, the earlier these opinions are taken into account in decision-making processes, the easier and more successful the implementation of urban policies and projects will be (Lin, 2022).

While the above cases illustrate the use of social networks for citizen participation in various urban issues, it is important to note that there are also dedicated platforms created specifically for this purpose. Some of these platforms are Courbanize, FixMyStreet, CitizensLab, etc. These platforms have their own traits, but they all aim to hear the citizen's voice. For example, FixMyStreet is a system in which citizens can make reports about various urban issues such as infrastructure problems, maintenance, etc. The specificity of this platform lies in linking reporting to location, limiting the possibility of reporting only to the area where the user lives or where he is identified as a resident. This mechanism can be interpreted as a limitation for citizens who, although not residing in that area, are connected to it through economic activities, services, etc. However, from another perspective, this approach can also be considered a form of protecting the confidentiality of information, ensuring that reports come primarily from local residents who reflect issues directly experienced in their daily lives. There are more powerful platforms that are based on GIS systems, such as Maptionnaire. This is a platform created by urban planners which, through sophisticated analytical tools, makes it possible to create questionnaires directly on the map, based on location. Citizens can evaluate various aspects of urban spaces, view opinions expressed by others, and contribute their development ideas. It constitutes a comprehensive citizen engagement system that is highly beneficial for urban planners, organisations, research institutions, and, most importantly, individuals.

It is important to note that such platforms offer more structured environments, mainly for receiving feedback from citizens about their urban issues than social media. This form of communication enables a more formal and reliable interaction between citizens and institutions, but what is noticeable is that communication on these platforms was between citizens, an intermediary party (that could be an organisations, activist group, etc.), and the institutions. So there was no direct communication with the institutions. However, this interaction tends to be more formalized than in social media, eliminating the subjectivity and disorganization that often exist in the opinions expressed in the latter. Social media networks, on the other hand, due to their extensive reach and the advantages discussed in the previous sections, serve as more powerful tools for strengthening citizens' roles in participation and for creating public awareness about urban planning issues.

3.3 Artificial intelligence in participation processes

The active involvement of citizens in the design and planning process is considered a key point that supports the sustainable development of cities. Participatory planning is essential in democratic governance as it enhances the legitimacy of policies through transparency and collaboration with citizens and stakeholders. Hofman (2024) contends that there is no definitive, quantitative answer for determining the optimal functioning of a society or the governance of a city, as the outcomes are contingent upon numerous variables. Therefore, the ability to discuss and agree on common problems and goals is considered one of the greatest challenges of democracy (Campagnucci et al., 2024).

Studies indicate that using innovative techniques to enhance collaboration significantly increases the probability that decisions align with the genuine desires and needs of citizens. The variety of AI-based techniques offers a great possibility of solutions that can be effectively implemented in participatory planning. AI is a term that is not necessarily associated with a single technology but with a range of technologies that have their own unique characteristics and functionalities (Clarinval, 2024). Therefore, it is critical to increase understanding of how each of these technologies works and can impact citizen participation before implementing sophisticated AI systems.

3.3.1 Defining AI

Just like the smart city concept, there is no single definition that sums up AI. AI is about simulating human intelligence processes through computer systems that have the ability to learn from data, analyze it, and improve themselves over time without requiring human intervention (Kamble & Shah, 2018). It is a branch of computer science that builds powerful systems capable of performing processes that require human intelligence (Ghosh & Arunachalam, 2021). This sophisticated technology has impacted almost every area of everyday life, such as business, healthcare systems, transportation, social relations, governance, etc. It has significantly improved the quality of life for citizens through systems that perform tasks in an automated manner, saving time and energy. Two main parts of AI are ML and DL, technologies that solve complex problems through the application of the algorithms they provide (Financial Times, 2024). Chapter 4 discusses both of these aspects of AI in detail. In the context of urban planning, these two technologies can be used to analyze citizens' opinions, to simulate various urban processes, to assess in advance the impact of various policies, and to identify inefficiencies in certain systems, such as the transport and energy systems.

3.3.2 AI categorization and it's applications in urban planning

AI's ability to solve complex problems and learn from data on a periodic basis has also begun to make a major contribution to urban planning practices. Despite the widespread use of systems and robots for monitoring public spaces, urban systems, and services, research in this area remains limited (Caprotti et al., 2022). According to Othengrafen (Othengrafen et al., 2025), technological systems in urban planning practices have been used as follows so far:

Energy and infrastructure system:

- Real-time monitoring and management of energy systems, optimizing energy consumption and helping cities transition to more efficient and sustainable models
- Forecasting energy demand, identifying system irregularities in real time or before they occur, reducing costs, etc.
- Creating an intelligent infrastructure

Mobility and Transport:

- Implementation of smart systems that monitor and manage traffic and vehicle circulation through sensors
- Modern infrastructure suitable for autonomous cars.

Public Management, health and safety:

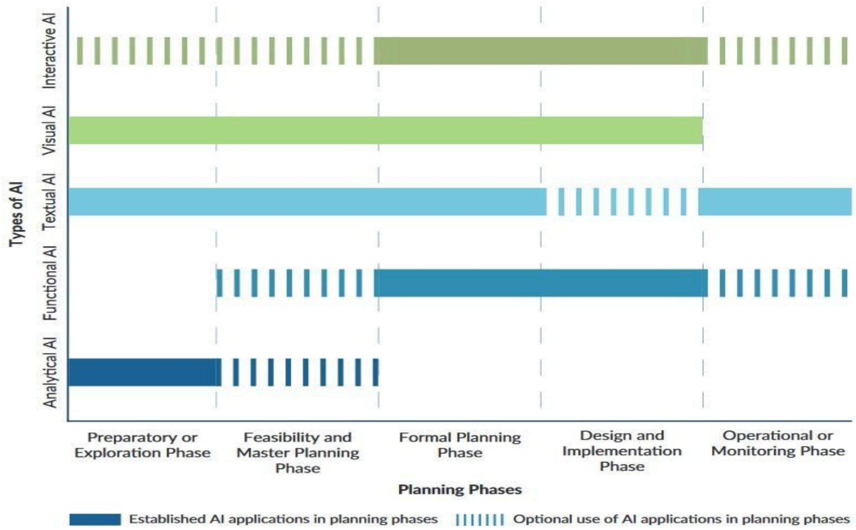
- Monitoring water quality, air quality, etc. through smart systems
- Data analysis to reduce the impact of global warming on the population, e.g. image analysis by generating models of where to plant trees (Ghisleni, 2024).
- Continuous monitoring of public spaces for public safety, etc.

Urban Planning, Land Use Policies:

- Preliminary assessment of the economic, environmental and social impact of urban policies
- Optimization of land use for simulations and analyses carried out through spatial data and satellite images, etc.

Like any other field, urban planning has certain principles and phases that must be followed before a specific plan or project is carried out. However, there are several types of AI, each with unique features that make them suitable for use in various contexts, including urban ones. A conceptual model that integrates the above-mentioned types of AI with the phases of urban dignity is presented in Graphic 1.

Graphic 1. AI in different planning phases



Note. Data source: (Othengrafen et al., 2025)

Analytical AI: This type of AI enables the identification, interpretation and presentation of hidden patterns in numerical or structured data (Sarker, 2021). The advantage of analytical AI lies in the ability to transform a large amount of data into valuable knowledge for making decisions or setting priorities. These systems mainly use optimization algorithms and predictive modelling to understand complex urban variables such as infrastructure capacity, housing needs, population distribution, its density, etc. (Yellowfin Team, 2024). An example of this system is UrbanSim, which analyses the impact of various policies related to land use on the urban environment.

Textual AI: It pertains to the examination of text-based data to provide material for semantic or sentiment analysis, among other applications. This AI system can process incomplete or unstructured data, including public comments and social media posts, and its analysis via NLP holds significant potential for comprehending the genuine needs and desires of citizens.

Visual AI: Computer vision and augmented reality predominantly use this AI variant, which aids in the recognition, categorization, and transformation of audio/video and image inputs into knowledge (Zhang et al., 2023). According to Sarker (2021) the primary capability of visual AI systems is their proficiency in transforming intricate data into visual representations, surpassing that of other data types. In the realm of planning, these AI systems are employed to oversee urban expansion, unlawful development, and alterations in land usage via the study of satellite imagery.

Functional AI: Similar to analytical AI, functional AI not only enables the identification and interpretation of patterns in data, but also executes these recommendations. Developers create functional AI systems to carry out specific tasks, which often operate autonomously by following pre-established rules (Bekker, 2019). Such systems in urban planning serve to monitor and notify about air and water quality, energy management in smart buildings, public transport scheduling, parking management, etc.

Interactive AI: It deals with systems that enable interactive two-way communication, such as chatbots or personal assistants (Adamopoulou & Moussiades, 2020). For example, in urban planning, it is mainly used to involve citizens in the process through questionnaires, collecting opinions from various platforms or systems, etc.

3.3.3 AI in participatory planning

AI is anticipated to enhance citizen engagement in environmental decision-making by providing access to an extensive array of data through advanced, user-friendly technologies (Clarinval, 2024). This involvement necessarily leads to the creation of a balance in the delicate relationship that exists between citizens and the governing bodies of their country. The diversity of techniques and software that AI brings provides a large number of solutions that must be used to achieve real and sustainable participation in development (van den Broek et al., 2024). In this context, this technology should not be seen only from a technical perspective, but also as an essential part of political and social structures and human relations. This means that AI involves a range of actors with different interests and goals.

It is developing at a very fast pace; for example, in comparison to Facebook, which brought a major innovation in the way people interact with each other, yet it took years to reach a user base of around 100 million, ChatGPT reached this number of users within 2 months (Duarte, 2024). Simultaneously, vast quantities of data are generated every day via social networks, online platforms, and various systems routinely utilized, creating a substantial demand for processing power to harness their potential.

AI has profoundly influenced the interaction between governing bodies and citizens, as well as the formulation of policies and decisions (Pislaru et al., 2024). A significant factor influencing outcomes is the cultivated capacity for transparent and inclusive decision-making. Using the techniques and algorithms provided by machine learning, these institutions can derive insights from the data amassed through predictive models and the analysis of citizen comments. As a result, this guarantees the accurate communication of public opinion and the clarity of the public's actual demands. In addition to these potentials, ML also offers the possibility of identifying risks or problems that are implicit or hidden in the data. This outstanding analytical and processing power makes AI a catalyst in urban issues, especially in relation to public participation in decision-making, increasing trust in the government-citizen relationship and generating policies with more effective results (Vitálišová et al., 2021). For example, by incorporating AI into any urban environment, it increases the efficiency of service provision to citizens, increases their trust in the government and improves the quality of public services (Ojo et al., 2019). According to Zuiderwijk (2021), the use of AI in public management by governments offers some benefits, including:

- efficiency and performance: efficient e-government services, task automation, error reduction, reduce administrative delays;
- risk identification and monitoring: effective monitoring of urban areas, improve fraud detection, internal and intelligent control;
- economic benefits: better resource allocation, improve productivity level, industrial automation;
- data and information processing: smart network, complex and multi-dimensional data
- benefits for society at large: security, flexibility, generate public value;
- public engagement and sustainability: citizen interaction, enhance transparence and public trust, better sustainability models due to data-driven decision-making;

The aspect in which AI has most influenced interactive government is the involvement of citizens in the decision-making process (Lahdili et al., 2024). Through advanced communication systems and online platforms, citizens can express their concerns and opinions. Some of these tools include social media, chatbots, and online forms, which assist decision-making institutions in making more responsible choices that align with the actual demands of the public (Vitálišová et al., 2021). Some AI applications in public engagement, based on the functionalities they offer, are:

- <u>Visualizing reality and the future</u> through interactive models enables citizens to participate in the urban planning process (Ng et al., 2024). Citizens can simulate the expected impact of an urban plan or project through these visual models. The AI technologies that enable this are mainly augmented reality (AR), virtual reality (VR), and GIS (Batty, 2023). Such an approach not only promotes transparency and broad inclusion but also motivates citizens to collaborate creatively and continuously for a sustainable city with high social well-being.

- The public's capacity to comprehend complex situations is significantly enhanced when they can operate, analyze, and interpret their demands via technological systems. Sophisticated systems, including GIS, crowdsourcing platforms, and visualization tools that report various analyses, assist in interpreting urban issues or problems more efficiently and in a simpler manner (OECD, 2024). Through these developed systems, the public has the opportunity to express its opinion, provide ideas and proposals, and illustrate its perspective through data analysis. As a result, the public is well-informed about the urban issues in their city, which makes them an essential participant in the formulation of policies and future planning.
- AI systems facilitate a more organized and democratic discourse on urban challenges. Individuals on these platforms experience greater liberty in articulating their viewpoints (Mendes et al., 2019). Analyzing data, categorizing expressed opinions, identifying trends, and understanding the overall sentiment of the public holds significant value for governments and organizations in the decision-making process (OECD, 2024). Online forums, digital questionnaires, etc. provide a suitable environment where people can discuss things with each other; analyzing these discussions allows decision-makers to have knowledge about the priorities of the public and their concerns regarding urban planning issues (Bono Rossello et al., 2024). This participatory method leads from passive participation, where communication is one-sided, to active participation, where citizens really contribute to the development of their future.
- Deepening participation is essential for developing and implementing more inclusive and democratic policies. By creating opportunities for diverse participatory mechanisms and strategies, governing institutions can create a secure system for obtaining real input from citizens (Konya et al., 2023). Artificial intelligence has created numerous opportunities for marginalized groups via diverse mobile applications and digital tools at a minimum cost (Arana-Catania et al., 2021). Local institutions or established communities can conduct training sessions or seminars to educate groups impacted by the digital divide, particularly in economically disadvantaged regions, enabling them to engage in community planning and

ensure their opinions are acknowledged. Table 3 summarizes some of the main AI applications for public participation.

Table 3. AI technologies application in public engagement

Technologies	AI integration	In participation
Visualizing reality and the future		
- Extended Reality - Digital Twins	VR, AR, 3D advanced modeling, AI simulations	Interactive urban simulations; AI-enhanced scenario forecasting
Understanding complex issues		
- Classification systems - Machine Learning - Sentimental analyses	NLP, ML algorithms, predictive models	Insightful participation; motivation to actively participate; transparent policy-making
Discussing issues and arguments		
- Deliberation platforms - AI agents	ML algorithms, pattern recogniction, generative AI	Simulate and evaluate possible scenarios;
Deepening participation		
- Recommendation systems - Chatbots - Automatic text simplification - Usability tests	NLP, ML algorithms, Computer Vision, LLMs	Improved navigation; AI assistants for better information; automation of suggestions based on historical data

Note. Data source: (Campagnucci et al., 2024)

3.3.4 SWOT analysis of AI in public participation

Public awareness of the potential offered by AI is essential in promoting acceptance and adaptation to this technology that has brought about radical transformations in every aspect of citizens' lives (Pislaru et al., 2024). AI systems provide numerous advantages that some individuals perceive as enhancing urban quality of life by minimizing various physical activities and in-person services; hence, they conserve time to fulfil their needs. Lahdili (2024) pointed out some benefits that AI technologies can add onto citizen participation.

- AI applications provide platforms for civil society to investigate diverse approaches to participation using advanced analytical tools applied to data previously inaccessible via traditional citizen engagement in planning (Savaget et al., 2018).

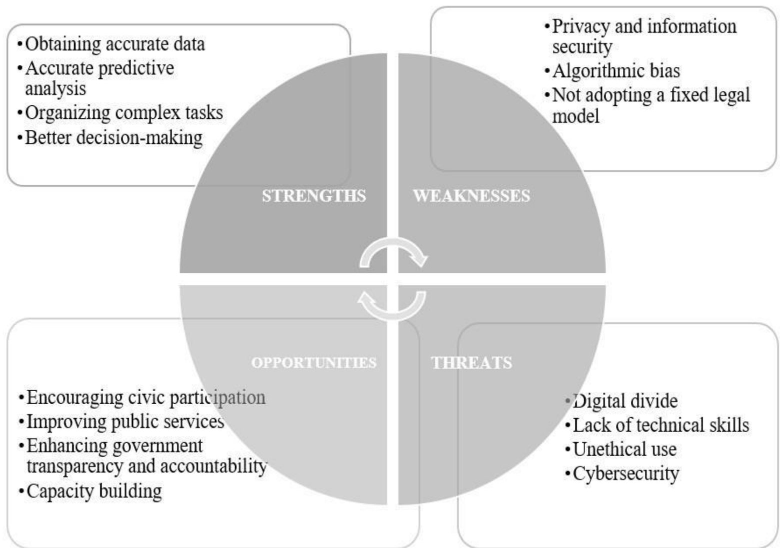
- AI enables the radical transformation of the public sector and administration by helping to establish a balance in government structures and the public (Yuan & Chen, 2025). In this way, AI influences an increase in transparency and legitimacy in the state's decision-making process.
- Interactive AI systems such as chatbots and digital platforms serve as a bridge between citizens and state institutions. These systems enable effective communication, broad discussions and the involvement of all interested parties in the urban issues that arise. Additionally, the advanced functionalities offered by digital platforms make it easier for decision-making institutions to justify their decisions to the public, which influences public trust and their active involvement.

As technology develops rapidly, the benefits of using it in civic engagement will continue to increase; however, there are also some associated risks. The risks can be social, economic, or ethical; therefore, it is crucial to develop multiple participation models that prioritize equality in participation, transparency, and data privacy (OECD, 2024). Potential risks include (Campagnucci et al., 2024; Lahdili et al., 2024):

- Opinion manipulation: When AI models rely on historical data to generate content or make predictions, it implicitly reinforces biases in that data. Such practices can lead to inaccurate representation of knowledge or perspectives, reducing the objectivity of AI systems in civic engagement (Feng et al., 2023).
- Exclusion of interested parties: AI agents that simulate various scenarios to assess a policy's impact on society and the urban environment may exclude less active citizens from their analysis due to a lack of data (Dekkers & Roet, 2022).
- Misinterpretations: AI models may also misinterpret data because they rely on algorithms that might not grasp all the nuances or perspectives present in the local context (Group, 2024). Therefore, it is essential that these AI systems are combined with human expertise to generate accurate and sensitive results that meet the needs and demands of citizens.
- Amplification of anti-democratic voices: Online participation may lead to the amplification of certain content through automated software known as bots. This prioritization of content or opinions based on certain metrics, such as the number of likes and comments, can sometimes lead to the generation of incorrect information or ideologies that conflict with democratic principles (Lim & Bentley, 2022). To avoid this, AI systems must be developed in such a way that they do not generate content based on engagement rate but rather encourage healthy debate

and present all perspectives in a balanced manner. Figure 23 illustrates a SWOT analysis of AI in participatory planning.

Figure 23. SWOT – AI in public participatory decision-making



Note. Data source: (Lahdili et al., 2024)

3.4 The digital turn in urban participation during the COVID-19

COVID-19 brought about a series of transformations in the way cities were functioning as a whole, especially in terms of communication, information, and participation. Citizens adapted to the situation by further exploring technology, turning it into a compelling tool to cope with and manage the created situation. Thus, the use of technology marked a significant shift in work and daily practices, which persisted even after the pandemic ended. Therefore, in the following sections is addressed the concept of civic participation during the pandemic.

3.4.1 Covid 19 as a driver for digital transformation and e-participation

The role of digital transformation in decision-making and public administration has increased significantly in the last 50 years, which has led to the improvement of governance practices through the internet and other technological tools, briefly summarized in the term e-governance. Recently, this way of governance has begun to no longer be treated as a purely technological and technical process, but as an innovation that holds at its core the fundamental principles of democracy, such as inclusiveness and transparency for the public. Such practices evolved at a galloping pace during the 2019 pandemic, where the world faced one of the most urgent pandemics in modern history, affecting every aspect of life, including public participation in decision-making and governance by leading state institutions. Almost all countries shut their borders, and people were locked in quarantine to avoid the further spread of the pandemic, with social distancing leading to severe challenges for people regarding their work and the performance and fulfillment of various services. In this context, a radical transformation was necessary not only in the way people interacted with each other but also in other areas (Back et al., 2020). Digital transformation was now considered an essential step in facilitating all necessary processes. This led to the development of online platforms that could coordinate consultations with citizens remotely. While this shift brought about a number of advantages and solutions for many countries, for others it further deepened the digital divide that existed between urban and rural areas, and communities in need who lack the infrastructure to engage in these systems. On the other hand, decision-making institutions updated their way of governance through the use of artificial intelligence and machine learning to perform real-time analysis and reporting. This posed threats regarding data privacy, and the automatic exclusion of marginalized groups that were unable to join these platforms also called into question the legitimacy of the decisions made. It can be asserted that COVID-19 forced decision-making institutions to take a closer look at the issues brought about by old participation models, and simultaneously highlighted the need to build new models and strategies oriented towards data and technology (Arnault, 2023). Numerous studies have shown that the pandemic greatly accelerated digital transformation, including the need for e-governance. In his study, Roztocki (2024) asserts that while the internet offered many services as an alternative, their use was not as widespread as that of traditional methods. For the sake of argument, the following expression can be presented, which might provide an explanation for the observation made by the author.

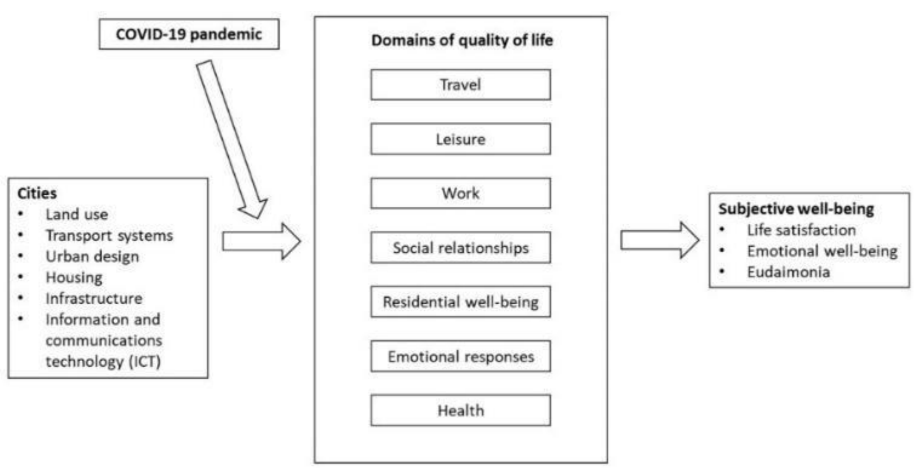
"Digital transformation is less of a digital problem than it is a transformation problem." (SolarWinds, 2021).

Online platforms became popular because they provided more detailed information than traditional media, and people were well informed about what steps they could take, such as e-voting, e-consulting, etc. Citizens felt more motivated to draft ideas and express their opinions on the decisions and plans of relevant institutions. This, in turn, led to concrete analyses with real data on public opinion, which assisted decision-making processes.

3.4.2 Digital technology and planning during Covid-19

Entirely new digital approaches to the urban planning process were developed in response to Covid-19, but although this transformation significantly increased the role of technology in planning, digitalization in this process was not something new. For instance, Wilson (1970) used digital tools for modelling in 1970, whereas in 1993 tools were developed for 3D visualization. In the 2000s, with the rise of widespread internet use, 86% of local authorities in the UK had published information online on their website (Wilson & Tewdewr-Jones, 2022). In 2004, when web technology was developed in version 2.0, the quality of these systems was greatly improved, as communication could now be dynamic, which presented a great opportunity for people to be involved in planning (Potts, 2020). However, despite people's adaptation to technology, the approaches employed exhibit a disparate degree of digitization in urban planning. Numerous studies argue that this change in terms of urban planning has come gradually and evenly over several decades and not as an immediate boom. This can be seen in the high levels of digitalization that have been used in this process. During the pandemic, several platforms such as Zoom, Microsoft Teams, Slack, Dropbox folders, etc., were used to support online work, while planners held online consultations and official documents were signed electronically. Studies have shown that during the pandemic, the role of transportation, services, etc., changed, directly linking it to the quality of life of citizens. Mouratidis (2021) studied how the relationship between the city and people's quality of life changed during the pandemic. Figure 24 presents this model.

Figure 24. COVID-19 reshaping the links between cities and quality of life



Note. Data source: (Mouratidis, 2021)

Travel was severely restricted during the Covid-19 period, especially public transport, as it was considered more dangerous due to a lack of social distancing. The legal institutions implemented strict measures, prioritizing biking and walking, thereby significantly improving people's quality of life. This mode of short-distance transportation proved to be an efficient means during this period of isolation when in-person activities were nearly impossible. In isolated conditions and with the majority of businesses and services closed, people began to spend more spare time in green spaces, significantly improving the quality of their lives. Cities contribute to social well-being by implementing policies that allow or prohibit social interactions between people. However, Covid-19 had a negative impact on these interactions. The notion of housing became essential during this period, since individuals were predominantly staying at home. This underscores the delicate nature of maintaining housing standards to guarantee basic and necessary conditions. Furthermore, the necessity of designing multifunctional common spaces, particularly in residential areas with small apartments, has been highlighted. The lessons learnt from Covid-19 address the need to support marginalized groups and undertake new inclusive strategies to increase the shared well-being and quality of life of everyone, not only in times of emergency, but also in everyday conditions.

3.4.3 Global Responses: Public participation strategies amid the pandemic

During the pandemic, all sectors, industries, and various professions faced great difficulties. For this reason, it was necessary for the government to develop efficient practices to avoid the spread of Covid-19 as much as possible, while also properly managing the emergency situation. Prior to Covid-19, engagement in the urban planning process in many countries occurred physically, through direct interaction or via media, typically functioning as a one-way communication channel sharing information with citizens without the opportunity for feedback. As a passive form of communication, it did not play a substantial role in the process. However, participation models changed significantly not only as a result of Covid-19, which served as a catalyst to show that radical change is needed, but also from the evolution of urban planning itself towards a more consultative approach rather than a formal or procedural one. One of the goals of e-participation and e-governance is to create several avenues for individuals to engage in decision-making processes (Iroz-Elardo et al., 2021). On the other hand, this entirely new approach to governance has introduced a challenge concerning the aims of engagement with the capabilities or opportunities that digital instruments may offer (Tundjungsari et al., 2012). Some of the changes the pandemic has brought to public participation are the following:

Changes in the structure and form of participation. The sudden shift to participation through digital platforms rendered traditional participatory methodologies obsolete, escalating the complexity of the tasks undertaken by urban planners and decision-making entities. However, these new strategies made it easier for everyone, by showing how well these technological systems worked compared to the older methods that relied on in-person meetings and basic data analysis without advanced tools. Yet, the need to use these systems in real time, even without prior testing, presented the society with major challenges. For instance, various organizations and companies had to choose the platforms they would work with in record time, which often required public training and a lot of technical support.

Combining the goals and objectives of participation as one of the principles of democracy with strategies developed during Covid-19. The switch to digital formats also influenced who would take part in this process and how the public would receive and manage information. The aforementioned digital divide was exacerbated during the pandemic, resulting in many residents, who struggled to adapt, being unable to articulate their viewpoints, thereby weakening the legitimacy of decision-making. This rapid transition led many institutions and organizations to adopt digital platforms for public participation without fully assessing whether they coincided with the objectives of the process. The result impacted the quality and efficiency of participation, as many of the systems used did not support two-way communication, empowerment, etc., which are listed as key factors in Arnstein's model (1969). As a result, participation was limited. Meanwhile, information was well organized for the public during this sensitive period, taking advantage of the many possibilities offered by technology to prevent the use of false data and to conduct valuable analyses and reports for the population.

Removing some barriers to participation through digital transformation, although the problem of the digital divide continued to be present. The use of online systems for the majority of the population significantly facilitated communication by offering flexibility in participation and working from home. Over time, the public became familiar with these technologies, further increasing the opportunity for developing new multimedia strategies and improving existing systems to address numerous problems encountered during the Covid-19 pandemic.

The budget was reallocated in an entirely new and challenging direction. When digitalization became necessary, there was a growing need for technical support at all levels and for the budget to buy licenses for software that was widely used by the public and especially by regulatory authorities. The complexity of budget reallocation increased due to the lack of time for in-depth analysis, which often necessitated the involvement of more dedicated staff and more effort to assess potential actions.

Organizational changes: Many studies and reports on a global scale have shown that advances in the field of technology offer enormous opportunities for the state in resource allocation, decision-making, gaining public trust through transparency, etc., leading to an ever-increasing demand for improvement at a national and international level (Ingrams et al., 2020). But it should be noted that this transformation differs from a technical and organizational perspective in countries with disparate cultural, economic, and social aspects. In other words, these differences depend on various factors, many of which are external. For example, organizational activities can help transform digital governance; increasing public transparency impacts the success of projects and initiatives undertaken, and the perception created among citizens is essential for adapting to technology. Tangi (2021) studied the factors that drove digital transformation in different countries around the world and argued that, in Germany, variables such as the expectations of external actors, legal obligations, etc. were what pushed this innovation forward. Meanwhile, in Italy, the support given by policies guiding the digital transformation was considered a driver, not paying much attention to cultural factors. Table 4 outlines some of the organizational and management elements that the COVID-19 pandemic's digital transformation has impacted.

Table 4. Organizational aspects influenced by digital government transformation

Organizational aspects	Definition	Examples
Tasks & Processes	Characteristics of the tasks and processes	Level of client interaction, level of standardization, type of task
Individual	Characteristics of the individual's duties and competences needed to perform the task	Attitudes toward using technology, technological knowledge, experience with digital services
Resources & Structures	Characteristics of the organizational resources and structures available to perform the task	Availability of infrastructure, management and political support, financial resources, strategy for digital transformation, system integration
Culture	Organizational regulations and values	Communication within and between government units, leadership culture, internal pressure

Note. Data source: ((Moser-Plautz & Schmidthuber, 2023))

During this period, other countries conducted in-depth studies on this issue, such as the Moser study in Austria. In many studies, this country was selected because it played a critical role in the response to the pandemic, being among the first countries to take strict steps to prevent the emergency situation, and also as it had made great progress in this direction even before this particular situation arose. These studies indicated that the pandemic not only caused radical changes in administration and decision-making but also affected the public's mindset towards these developments. Furthermore, the organizations that suffered the most damage due to their way of working via face-to-face services without any innovative infrastructure are the ones that underwent the most evolution.

<u>Changes on participatory approaches</u>: Since participatory initiatives are based on building trust through transparency and collaboration between the public and the state, the pandemic further deepened this challenge through social distancing. Warner Macintosh (2020) emphasizes that there is a close relationship between material goods, social capital, access to health care, and reliable information. Therefore, to achieve participatory decision-making, new strategies had to be created.

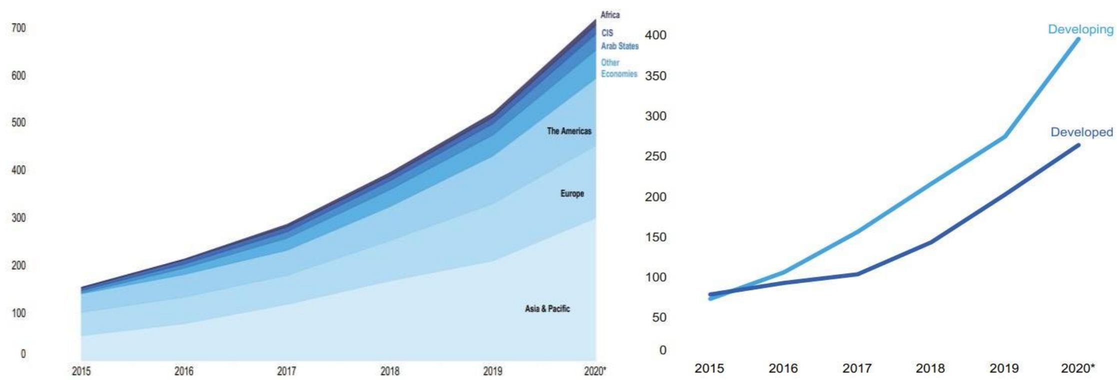
3.4.4 Challenges of participatory urban planning during the COVID-19 pandemic

Since the Covid-19 period caused a great shock in every aspect of life throughout the world, the necessity arose to create new work and collaboration strategies. Traditional planning methods, which had a completely different approach from the virtual one that was created, had to be simplified or totally changed to ensure the continuity of this process (Rajhans et al., 2020). It would not be accurate to assert that the use of technology began during this emergency period, but it should be acknowledged that the great surge in the use of digital tools and programs that could have been developed long ago took place precisely during that difficult chapter, both economically and socially. Many innovative countries praised the potential of these tools and benefited from them, however critics added that only those in traditional decision-making systems would continue to participate, with the rest remaining inactive. And yet the situation created demonstrated the opposite. Germany was the first country to consider virtual participation in urban planning after 1990, which demonstrates the country's prioritization of involving citizens in decision-making (Pantić et al., 2021). The challenges of inclusion through technological means in urban planning are not necessarily related to the transition from traditional methods to virtual methods guided by advanced systems. The emergency situation of the pandemic itself caused delays and cancellations of processes, and regardless of how quickly people managed to adapt to this transformation, virtual participation faced challenges that were present even in the traditional methods previously used. This period also revealed the flaws in the design and framework of traditional inclusive decision-making strategies. Consequently, these limitations led to difficulties in involving all citizens in the process, especially marginalized groups. These challenges can be categorized as follows:

a) Accessibility

   This concept addresses the disparities in participation that emerge when technology and the internet become integral to daily life. This category includes online work and media used for pandemic updates, as well as guidance from the Ministry of Health, which may lack the detail found in traditional media and involvement in community plans developed for citizens (Pantić et al., 2021). This problem is greater among groups excluded due to various economic or social factors, or even due to living in rural areas. In developing countries, the technological infrastructure in rural areas differs significantly from that in urban areas, leading to issues with inclusivity in planning. The fact that rural areas usually have a large elderly population means that in addition to IT infrastructure challenges, they also face challenges when it comes to technical support and the knowledge required to access these resources. Based on a study conducted by the International Telecommunication Union (ITU), the number of internet users globally increased from 4.1 billion in 2019 to 4.9 billion in 2021 (ITU, 2016). However, about 2.9 billion people, 96% of whom lived in developing countries, did not have access to these technological systems. In Figure 25, a sharp increase can be seen in bandwidth used globally from 2015 to 2020, whereby the urgency created during the Covid-19 pandemic is easily discernible.

Figure 25. International bandwidth by region and by development status during COVID-19 crisis



Note. Data source: (International Telecommunication Union (ITU), 2021)

Bandwidth is an indicator that measures the maximum amount of data that can be transmitted in a given period of time between two points on the network. Therefore, it establishes the maximum capacity for information exchange via an internet connection. In this case, it may be noted that internet traffic had been constant until the pandemic period started, which marked a drastic change in the demand and need for internet use. The graph indicates that developing countries, typically those with larger populations, caused a significant increase in internet traffic. Despite the limited access per user, the overall bandwidth remains substantial. This also arises from the fact that these countries had to switch directly to digitalization, without experiencing a gradual increase in demand for the internet, equipment, and specific software. The urgency of using these tools during the Covid-19 pandemic highlighted the enormous importance of international cooperation to ensure equal access to digital participation.

b) Reliability

There was not much knowledge on virtual methodologies used for participatory planning. Given that virtual participation had to initially be improvised, this approach still faced many challenges, even after some time had passed since the start of the pandemic. For instance, it is important to highlight the challenges in adapting to new methods, the absence of the techniques used for online participation, the failure to effectively target a broad audience, the deficiency of informal face-to-face dialogues, and the lack of body language to express oneself more easily (Venter, 2019). This new strategy, which came about in a brief period of time, was seen with suspicion, especially in developing countries where citizen participation had been physically difficult to achieve for the entire public. With fewer virtual participants in planning, there was an increased risk of creating false knowledge, as it often did not represent the opinions of the public as a whole (Losa Rovira et al., 2022). Various decisions or projects also used online voting mechanisms, allowing citizens to participate anonymously. Despite the great opportunity to express their opinions and influence the development of various policies in their country, citizens were often not well informed or trained about the concept that the plans and projects represented, resulting in useless votes. For example, Serbia, within the framework of the "Green City Action Plan for the City of Belgrade" project, used this mechanism during the Covid-19 pandemic (Mihajlov et al., 2021). However, a lack of understanding in certain aspects of the project was observed, emphasizing how important it was to guide this process by experts with the appropriate explanatory and collaborative skills. The concept of reliability can include a series of issues that carry great weight in the context of participatory planning, especially in the virtual one. One important issue to consider in this context is the rigidity that virtual discussions via various software can exhibit. The absence of body language often restricts conversations, preventing them from expanding beyond the immediate focus. This limitation can hinder the emergence of valuable discussions that might reveal overlooked points (Rahman & Mehnaz, 2024). In virtual media, abstraction is one of the properties that, to some extent, reduces the reality of citizens' daily lives through factors that may seem insignificant.

c) Trustworthiness

Participation through online platforms primarily tested the mutual trust between experts and the state, as well as the public's trust in government policies. But even though online platforms for participating and performing various services are somewhat stabilized today, a portion of the population still prefers traditional methods for communicating with the administration, making purchases, etc., because they have not yet created the requisite trust in these systems. According to experts, there are several factors that lead to this distrust of virtual participation, such as fear of losing personal data, non-personalized participation, non-transparent political systems, among others (Gommesen, 2025).

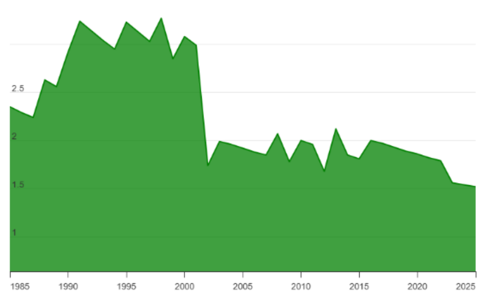
3.5 The interest and the relevance of this topic in Albania

After addressing theoretical concepts of smart cities, the components that make a city smart, the principles for successfully implementing participatory planning, the importance of citizen involvement in the planning and management of urban spaces, etc., it is important to contextualize this approach to urban planning in Albania. As mentioned, Albania, being a country that has transitioned from entirely different political regimes, has undergone major changes in the way the state itself has functioned. These changes include radical political decision-making and cultural, social and economic transformations. The transition from a centralized decision-making system to a free market economy presented numerous challenges for institutions and society, particularly in managing territory, as people began migrating uncontrollably to cities, resulting in a self-organizing environment. Faced with a significant lack of institutional capacity and prioritizing economic growth, the voice of citizens in decision-making processes was completely neglected. However, over the years, a series of economic, political, and infrastructural reforms have been carried out with the aim of creating a more structured urban system and increasing social well-being. But, despite these improvements, the involvement of citizens in decision-making processes on issues directly related to the planning and management of their residential area remains at minimalist levels. Traditional participation methods like public hearings and community consultations are still used, but they are mostly useless or unrealistic. They are conducted in a hermetic manner with very few citizens present, so even if real, these hearings cannot represent public opinion due to low participation. Thus, it is noted that, in addition to the problem of failing to recognize the importance of the public's voice in relation to urban issues that directly impact them, there are no initiatives that use the advantages offered by technology, especially social networks. In Albania, although the technological infrastructure is still far from the proper level (mainly in rural areas), social networks are widely used by all generations. The problem seems to be that relevant institutions neglect to consider citizens as important stakeholders in the formation of urban policies, rather than stemming from missing infrastructure or society's failure to adapt to these instruments. This gap have created a non-inclusive decision-making model, undermining one of the fundamental principles of urban sustainability. In this context, it was considered appropriate to explore how AI and ML can support participatory planning through social media in settings where citizens' voices are still under-represented. Consequently, this research takes as its case study the capital of Albania, Tirana—the city that has been most affected by the phenomenon of urbanization and from the instability that characterized the 1990s.

3.5.1 Tirana urban planning after 90s

Tirana is a city with a current population of 536,000 citizens (MacroTrends, 2025; World Population Review, 2025). Since 1929, it has been the subject of many works for urban and architectural development due to the numerous transitions it has undergone. As a city in apparent transition, it presents a transitional period of urbanization in different historical phases as a result of a series of factors that occurred after 1990. To gain a clear overview of the city's transformation, it is necessary to study its historical development, particularly following the change in political regime that occurred after the 1990s. After these years, major economic, social, political, cultural, urban and architectural changes took place in Albania, bringing great irregularities to urban spaces. Many green spaces were built, and many informal buildings occupied large areas of the city, bringing major environmental consequences. This came as a result of the lack of settlements for a long time, poverty, and especially the lack of specific laws for construction. In this context, citizens saw informality as the only alternative, since the legal system at that time did not provide affordable opportunities for the majority of the population due to complicated legal procedures and unfavorable market prices. Additionally, the transition from a centralized economy and the allowance of free movement starting in 1991 led to an increase in immigration from rural to urban zones. The graph below show this large movement within a very short period of time.

Graphic 2. Tirana population annual change



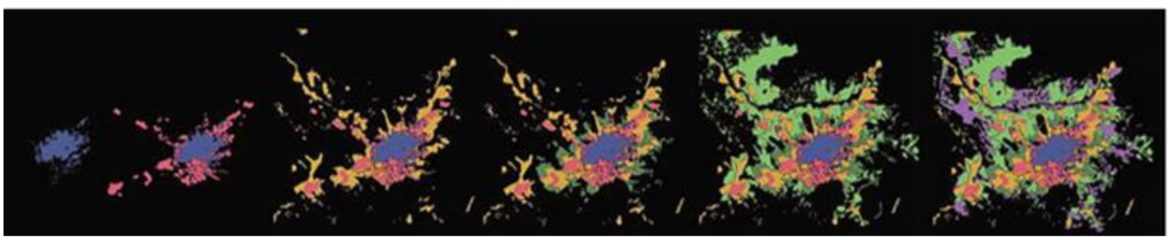
Note. Data source: (MacroTrends, 2025)

However, many of these large population movements was driven not only by the need for better housing in more favorable geographical locations at a low cost but also by the desire to establish businesses that cannot be realized through legal procedures. In this context, these constructions (a large part of them informal) were developed in two main directions:

1. For housing purposes, in the peripheral areas of Tirana
2. For business purposes, in areas around the city center

These uncontrolled movements resulted in the formation of unplanned neighborhoods on the outskirts of the city, highlighting a significant deficiency in local institutions responsible for designing and implementing controlled development policies, as well as a lack of coordination between these institutions and citizens. In the figure below, the creation of these new neighborhoods without a prior plan is noted, resulting in spontaneously organized areas developed by citizens who had lost trust in the decision-making authorities.

Figure 26. Tirana expansion from 1920 to 2010



Note. Data source: (Dhamo, 2021)

Figure 27. The emergence of new urban districts in Tirana

Note. Data source: (Dhamo, 2021)

In essence, the absence of a development strategy and insufficient engagement with citizens resulted in a somewhat chaotic situation. The issue with these constructions extended beyond the building permit, as it was present in many other projects. The issue was the inability of institutions to coordinate their decisions with urban planning regulations (Aliaj et al., 2003). Conversely, the rapid population growth led to significant challenges in managing urban spaces complexity, distributing resources, and addressing inadequate infrastructure.

Around 2000, the main planning mechanisms gradually began to be reformed but faced great resistance to their application. This reform was made necessary by the chaotic situation and the need to give proper direction to urban planning and urban spaces management, which was developing beyond the necessary standards. Foreign donors and domestically created organizations like Co-PLAN inspired the development of a strategic vision and innovative programs instead of the traditional plans used. But the policies undertaken were not very successful, leaving the urban planning process, which was already considered 'traditional', free. But in fact, there was no such process. Uncoordinated planning led residents to create and shape their settlements, often resulting in social division and the creation of an uncooperative spirit for the community. The figure below show images of several built-up areas in Tirana last years, where a discontinuity in urban planning is noticeable.

Figure 28. Different urban morphologies in Tirana

The first two photos illustrate buildings that are positioned near the city center of Tirana, and what is most noticeable is the irregularity in their planning and urban densification. Despite the modernization of the facades, the buildings are very solid in terms of the supporting infrastructure that is necessary, such as greenery, public spaces, etc. This situation shows that urban development is fragmented. On the other hand, the remaining photos depict the peripheral areas of Tirana, where an even more irregular construction model is evident, with new projects coexisting alongside existing buildings. The mixing of construction typologies and the partial infrastructure bring out the spatial imbalance of the city. This imbalance indicates that the city's development lacks a genuine strategic model capable of addressing all urban aspects.

In general, this panorama shows a city created mostly by spontaneous particles that shape the physical structure of Tirana. However, from a holistic perspective, it is precisely this informality that makes Tirana an ideal model for understanding the specific processes that characterize emergent urbanism. According to Dhamo (2021), in this city the balance between spontaneity and authoritarian decisions has always been shifted to the extremes, leading to the creation of a non-cooperative spirit between them. In this way, it has been impossible to take into account the opinions of citizens, significantly affecting the decrease in trust in institutions and the creation of dynamic situations that have led to uncontrolled transformations in the city.

Logically, planning must go through several phases, including drafting the plan, securing the necessary infrastructure and resources, and finally implementing the plan. It seemed during those years that this sequence was completely reversed. In his book, Aliaj (2003) calls this phenomenon the ‘head-scratching’ of the planning phases. The planning in Tirana is typically decided from the top without real public participation, even though the citizens themselves have always been more protective of the city than the authorities or experts (planners, architects, etc.). Despite initiatives undertaken from time to time by various organizations, planning with broad public involvement did not become a working practice for the relevant bodies.

3.5.2 Participatory planning in Albania, Co-Plan case

As mentioned, urban planning in Albania has gone through several main phases and timelines, but each of them represents a completely different approach to urbanization. The major transformations that took place in Albania during the 1990s caused the economy, politics, and society to undergo a shock that created a difficult situation for the entire country. Despite the situation created, decision-making bodies tried to take restrictive measures and establish rules. However, they were unsuccessful because those institutions themselves were not properly organized as a result of their lack of experience under the previous ruling regime. In these years, the country needed more ‘lessons’, ideas and examples to follow as reference models than untested and uncoordinated austerity measures among the relevant institutions. Co-PLAN was established in 1995 as an independent unit with expertise in territorial management and urban planning (Co-PLAN, 2017). As a civil society organization, it made a series of efforts to improve the existing situation, while facing however a number of economic, social, and, above all, political challenges as a new and inexperienced organization. The basic goal of this organization's beginnings was to contribute to the social development of low-income communities by empowering citizens through community organisations and civil society initiatives so that they could influence the improvement of their neighborhoods. In relation to this goal, it is understood that Co-PLAN essentially developed bottom-up initiatives, influencing the increase of citizens' voices in the development of their cities. One of the first projects of C0-PLAN was the “Breglumasi Programme”, which took a series of concrete steps towards improving neighborhoods from 1995 to 1997 and later led to the official institutionalization of Co-PLAN as an NGO by the municipality of Tirana. Over the years, the goals and objectives of this organization expanded, providing expertise in urban development projects, training and capacity building assistance, scientific research, etc.

The 2000s coincided with a difficult period in Albania, as society had to move towards a more open, democratic mindset and the state itself had to gain stability in its position. An important initiative of Co-PLAN in this period was the coordination with official state institutions for participatory planning. Here, the case of the national project “Urban Land Management Program” can be mentioned. Within its framework, Co-PLAN organized a series of activities (forums, consultations, etc.) in collaboration with the World Bank Office (WBO) in Tirana, with the aim of creating an inclusive and democratic atmosphere in the public by identifying the most active community groups and facilitating their interaction with decision-making bodies.

Such initiatives were undertaken in a number of cities in Albania, such as Korçë, Peshkopi, Fier, Elbasan, etc. After a series of successfully implemented projects, the organization built a public platform in 2005 to better structure territorial developments by the relevant authorities (Aliaj, 2009). Furthermore, Co-PLAN tested how much impact inclusive planning initiatives would have in different urban situations. This concept was tested in the historic city of Kruja, which at that time experienced a massive population exodus, bringing radical changes to the economy. One of the main conclusions was that the greatest limitation in the development of comprehensive policies in this area was the lack of local capacities for designing innovative ideas and adapting strategies to the context. Such initiatives were also tested in cities with more difficult economic and social contexts, as in the case of Peshkopi.

In the period 2003-2006, a series of initiatives and projects were carried out in collaboration with foreign organizations, that moved from participatory planning at the community level to urban governance. This process created a stable basis for further developments, which in recent years have taken on another dimension due to digital transformation, as well as economic and social changes. Furthermore, in 2014, a technological platform (Leviz Al) was created with the aim of encouraging participants to be active and efficient. By mobilizing local actors to give their opinions and make complaints and requests on the platform, it leads to increased transparency on the part of decision-makers, further developing the ability of these institutions to provide more efficient services and policies. This platform, shown in Figure 29, is still active, and many actors have responded to this initiative. This data demonstrates that the comprehensive mechanisms undertaken by the Co-PLAN organization (in collaboration with various national/international organizations and institutions) have been successful.

Figure 29. Leviz Al platform

Note. Data source: (LevizAlbania, n.d.)

In 2017, the KINDLE Advocacy project was implemented, which aimed to leverage evidence-based advocacy by civil society organizations and activists on urban issues, democracy, and policymaking. For this purpose, a specific capacity-building program was developed with structured workshops and training, and their results were compiled into policy recommendations that were proposed to responsible entities. In addition to these, Co-PLAN has also implemented other initiatives that have had a significant impact, such as SPARKS, SAIL, and, most recently, IdeAL, to create channels of cooperation between citizens and decision-making institutions.

A further conclusion from the Co-PLAN experience is that using technology in its initiatives and activities has positively impacted the expansion of the participation process and accelerated project implementation, resulting in quicker urban integration. For example, in the case of the project in Breglumasi in 1995–1997, which used classical planning methods and instruments (hand-drawn plans, social questionnaires, etc.), it was difficult to analyse the materials in a linear timeline manner. In projects where different software and GIS platforms were used, the process was much easier because the digital data on the socio-economic panorama of the area was more complete and clearer, making it possible to subsequently implement the plans within a relatively short time. This led to a significant increase in the credibility of such inclusive processes.

Essentially, what is understood from this description of Co-PLAN initiatives, is that urban planning and management was seen as a citizen-centered aspect and not as a technical process. Precisely for this approach, it was considered important to include these successful initiatives in this research topic to show that such initiatives can significantly affect the improvement of people's quality of life through their consideration as key actors in the formation of the city. An analysis of the implemented projects and initiatives inferred that citizens desire to participate in various urban planning and development processes; however, the procedural mechanisms often alienate and demotivate them. Transparency in such cases is the key that helps increase trust among citizens and motivate them to still live in Albania, which is facing a massive population exodus to other countries. In this case, for Tirana's planning and management process, it can be asserted that urban development does not value citizens' opinions, even though they are the ones who make up the city and experience the policies every day. It may seem like a negative approach towards the work being done in this direction in Albania, but in this case, where the successes of Co-PLAN's inclusive projects and initiatives are evidenced, the question arises: Why are citizens active and motivated to participate in them and not involved in initiatives and projects undertaken by institutions? The answer is very simple: they are not involved because firstly there are no real inclusive initiatives and secondly they do not trust that their opinions will be considered. So to some extent, they have lost hope in the transparency and legitimacy of the institutions, since no urban planning legislation explicitly highlights the role that citizens play in this process. It may take a significant amount of time and dedicated strategies to properly address this alarm. As previously mentioned, this is the problem raised in this study, the non-participation of citizens in the process of urban planning and management in Tirana, which Co-PLAN has successfully overcome. But Co-PLAN is only a sub-unit that is acting in this direction, but what will happen to the whole of Albania?!

3.5.3 The approval process of an urban project in Tirana

From the examination of all informational sources regarding government information on institutional portals of territorial development and published official documents, it is noted that there is a standard path that is followed in the approval of an urban project depending on its type. Of course, such an implementation format is based on legislation approved by the relevant authorities. The formulation of a Detailed Local Project (DLP) entails a sequence of stages that must be meticulously adhered to achieve a favorable outcome and secure approval from the pertinent authorities. The DLP provides detailed information, such as the development method of the zone, based on the Local Comprehensive Plan (LCP); development conditions, including detailed maps accompanied by analyses describing the existing situation and maps with proposed territorial and engineering definitions, the position within the city etc. (Tirana Municipality, 2018). After the report has been prepared with the necessary details according to the regulation for drafting a DLP, the draft is submitted to the Directorate of Territorial Planning which publishes it in the municipality's online systems for a certain period of time. It is precisely during this period that the project remains open for public recommendations and consultations. In this very important step, public hearings can be organized by the municipality, or recommendations can be sent in writing to the Coordinator for Public Notification and Consultation. In this way, the recommendations are delegated to the relevant units, and if they are not accepted, a reasoned response is returned; otherwise, the recommendations (in summary form) are attached in the form of a report to the approved act. The next steps are bureaucratic procedures that are followed by the relevant authorities until the final approval of the project and its implementation according to the established standards.

There are also other types of projects that pose specific cases of a DLP such us a Local Mandatory Plan (LMP). In these specific cases, like the reconstruction of the "5 Maji" neighborhood after the earthquake, the approval steps differ. Specifically, after the technical assessment, the plan is drafted by the responsible planning structures in cooperation with the National Territorial Planning Agency (NTPA). The next steps include the approval process by the municipality, publication of the project in the National Register of Territorial Planning, and recognition by the National Council of Territorial Planning. Finally, based on the decision of the Council of Ministers, the plan is integrated into the LCP.

It appears that the approval of such a project follows standard stages that are clearly defined in legal terms but which often remain closed, without public consultation. Being a non-inclusive process, which focuses on the formal fulfilment of deadlines and administrative procedures, affects the acceptability of the project among the public. The 'Tirana Riverside' project is a prime example of this, as the residents who were expropriated (with the right to compensation), based on the data analysis (which will be discussed in Chapter 5), were not involved in the design or decision-making for their new neighborhood. This is the reason why this project was chosen as a case study in this research. The top-down logic of planning without bottom-up input fully aligns with this approach, thereby undermining citizens' trust in the process.

3.5.4 Methods of public consultation in Tirana

<u>Consultation through public hearings</u>

Creating more efficient communication mechanisms with the public is necessary to influence the acceptability of the project and to build citizens' trust in decision-making institutions. Public hearings are a traditional way of communicating with citizens; they allow them to present their recommendations, complaints, requests, and priorities regarding various issues related to the project (Tirana Municipality, n.d.). However, in Albania this form of involvement has not proven very effective because participation is usually low. The low number of participants results in this process having little impact on the project. The widespread non-participation of the public may be due to several reasons, such as:

- Lack of information because usually announcements about them are made on the municipality's or NTPA's online websites.
- Distrust in the authenticity of the process. Based on preliminary analysis of the data collected, citizens are largely distrustful of the quality of the inclusive mechanisms used by institutions.

<u>Consultation through public exhibitions</u>

There are major projects that use more beneficial forms of public involvement through their display in various creative exhibitions. The purpose of these exhibitions is to simplify the interpretation of seemingly complex projects for the public and increase transparency. However, although these forms seem more inclusive, they are not widespread. Participation is often limited to those citizens directly affected by the project and as a result the impact of this form is relatively narrow.

Consultation through roundtables with experts and various interest groups

This consultation format involves experts and selected groups interested in the project. This approach is efficient because it manages to identify specialized technical approaches that improve the planning process by addressing critical aspects that need to be prioritized depending on the context. However, participation is selective, excluding citizens.

There are also other forms of consultation, such as groups created in administrative units, online platforms, etc., but in general, it is noted that almost all of these forms have the same drawback: the exclusion of marginalized groups. Typically, marginalized groups in society are considered low-income communities, those living in suburban areas, older age groups, minority groups, etc. Economic, social, and cultural barriers frequently exclude them from the process, and the absence of specific methods for their inclusion results in decision-making that does not accurately represent the genuine needs of all individuals.

3.6 Summary

Digital transformation has significantly impacted urban planning practices recently, bringing about major changes with innovative solutions to address the challenges faced by traditional planning methods. In this way, adaptability to technological tools and systems has become a necessity for urban planners, not only to develop democratic and sustainable cities that respond to global challenges such as urbanization. Covid-19, a global period that presented great challenges to the world, acted as a catalyst for promoting rapid development. As a result, both governance and communication methods used by institutions to engage with citizens changed significantly, introducing new systems that encouraged active citizen participation. Furthermore, the use of online platforms made decision-making more responsive by enabling data-driven processes. However, the situation created also served to highlight the major gaps that existed in the technological infrastructure, including the lack of capacity to use the systems offered. Despite these problems, even after the end of the pandemic, the digitalization of public participation continues to innovatively change urban planning practices around the world. ML algorithms and sophisticated AI systems are indispensable in everyday life because they can provide solutions to complex problems and learn from historical data. This perspective also includes the potential offered by social media to increase interactions between institutions, urban planners, and citizens. Since citizens feel free to express their opinions on these platforms, they constitute a tool with high potential for conducting accurate analyses in real time. In many countries, this communication channel is being considered as a mechanism that can be used by institutions to increase participation in planning processes, to motivate citizens to be active, to be transparent in the decisions taken and especially to ensure that their policies meet the real needs and demands of the community. Within this framework, urban planning in Albania was addressed from the perspective of the transition after the 1990s, where Tirana, as the capital of the country, represents a more complex environment. Thus, the continuous urban changes and the increasing demands for inclusiveness and transparency highlight the gaps created in terms of urban space management. This analysis emphasizes that the potential offered by technology, specifically AI, in supporting participatory planning through social media is crucial, especially in developing countries that have experienced major transitions where the need for inclusiveness is an urgent necessity.

CHAPTER 4 - ML & NLP Infrastructure for Participatory Planning

This chapter discusses the technical and methodological basis of the citizen-driven framework proposed in this research. It provides detailed explanations of the algorithms used in machine learning (ML) and deep learning (DL), as well as the techniques used in natural language processing (NLP). The purpose of this chapter is to provide a clear basis for the logic followed by each mechanism and algorithm used in the case study. Given that the research topic combines two different disciplines, such as urban planning and computer science, a technical explanation of the implemented algorithmic methods was considered reasonable. Moreover, it is important to note that the application of these mechanisms in participatory urban planning, which are core components of AI, is discussed in Chapter 3. In this context, the detailed content in this section serves as a bridge between the conceptual model and the empirical work done within the framework of the research.

4.1 Machine Learning

ML is a subfield of AI that has led to a radical transformation of industries, scientific research, urban systems, and the way people interact in everyday life (Hapuarachchi et al., 2025). As a core part of AI, it offers unique functionalities that enable computer systems to learn from data and improve their performance based on historical data without the need to be specifically programmed. Moreover, ML models facilitate the formation of diverse patterns by discerning relationships among multiple variables that are nearly impossible to understand through basic statistical analysis (Brown, 2021). Above all, its potential to generate predictive models from provided datasets makes it a crucial technology in many disciplines, including urban planning. Moreover, as the world faces significant changes due to rapid urbanization and advancements in AI, the ability of ML to dynamically integrate with data positions it as one of the greatest opportunities presented by digital transformation. This technology offers several advantages, including efficiency in automating complex tasks, scalability across domains, the ability to make decisions based on insights gained from data, and the ability to adapt to environments with different dynamics (GeeksforGeeks, 2024c). Several of these benefits are outlined below.

- Improved decision-making

Integrating ML techniques into organizations that have AI at the core of their work comes with the potential to provide automated decisions or help experts determine the best possible decisions (Li et al., 2024). By training on very large datasets, identifying patterns in the data, and generating predictive models, this technology enables AI systems to analyze new data in a non-invasive manner and make decisions with high accuracy based on knowledge gained from historical data. Therefore, ML is considered the driving force for decision-making in many sophisticated AI systems (Namvar et al., 2023).

- Enhanced accuracy and efficiency

  Because of its sophisticated capabilities, ML markedly differs from conventional technologies that facilitated the decision-making process (Collins et al., 2021). Since it possesses an advanced learning capability, functioning autonomously by assimilating data and generating models, it eliminates human errors and enhances efficiency.

- Tasks automation

  By automating several processes related to data, ML enables the real-time processing and analysis of substantial data quantities (Kotteti et al., 2018). Unlike traditional technologies employed for this purpose, which necessitated extended periods of time to finalize the process, the precision of the outcomes was quite uncertain. Unlike traditional technologies employed for this purpose, which necessitated extended periods of time to finalize the process, the precision of the outcomes was quite uncertain. Whereas, automated data analysis through ML techniques provides the advantage of reducing operational expenses, such as reducing the need for a specific number of human resources in data analysis, reducing the risks of human errors, enabling rapid predictions, etc. In the context of urban planning institutions, these factors enable effective positioning within the urban environment by adapting to citizens' real needs and responding to urban challenges, including environmental, organizational, and social issues, through the proper integration of AI and ML mechanisms into their work practices (Pomeroy, 2024).

- Scalability

  Scalability of ML models is very important to manage and perform complex tasks, and it refers to the capacity of a model or system to process large amounts of data without compromising performance or accuracy (Hapuarachchi et al., 2025). This feature allows ML systems to perform many processes in a cost-effective and time-efficient manner, serving millions of users worldwide. A scalable system offers the possibility of parallel processing and adaptation in record time for the model with new data, which is very critical and valuable for managing the enormous amount of data that is generated every day (Ali, 2025). This essential quality of ML becomes even more crucial in widely popular systems, such as social media, urban issues, and health.

- Personalization
  The ability of ML to provide personalized services and recommendations is related to the personalization of the user experience. By analyzing the behavior of users of online platforms, systems, and social networks, ML algorithms can understand preferences for products, services, or issues related to different topics, providing them with dedicated content, recommendations or services (Cherukuri, 2024). Studies have shown that this ML capacity significantly impacts user satisfaction, which translates into active participation, higher retention rates, and improved decision-making processes for system users and developers.

4.1.1 Core ML concepts and supervised learning approach

Based on the nature of the data and the desired results, ML algorithms are divided into several categories, as they require different methodological approaches. In order for these categories to be clearer, it is important to first understand some concepts, such as datasets, features, similarity measures, and labels.

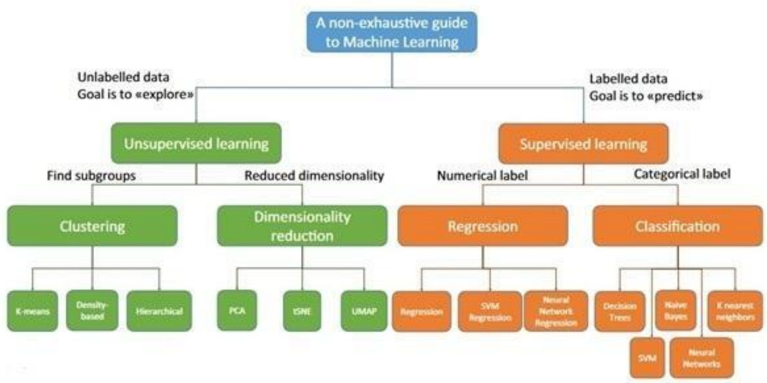
A dataset is an organized collection of data, where each row represents a single instance or entity and each column a specific attribute. Thus, each entity consists of a set of attributes that describe its characteristics, and their structure is essential in determining the effectiveness and accuracy of analysis results.

Features are the qualities or characteristics that the model uses to make predictions. They are variables or attributes that represent the data and allow the model to learn from the relationships that exist between them (GeeksforGeeks, 2024a).

A label is a target or independent variable linked to each instance in the dataset, particularly in supervised learning. The model's design anticipates this outcome. In a collection of emails, features may include the content of the message, word frequency, etc., while the label could denote 'spam' or 'not spam'.

Figure 30 illustrates the two main categories of ML and their corresponding matching algorithms, but since the supervised learning approach was used in the empirical work in this research, only this issue will be addressed below.

Figure 30. Taxonomy of ML algorithms

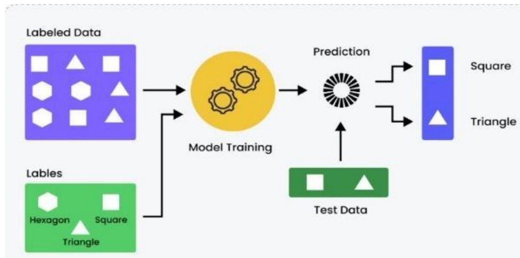


Note. Data source: (Badillo et al., 2020)

Supervised learning

Supervised learning is a type of ML that uses labelled datasets to train algorithmic models with the aim of learning general rules that determine the relationships between input features and output (Rathod, 2024). Thus, the objective for this learning process is to generate a model that can accurately predict outcomes for new, real-world data. In this ML technique, the target variable is known at the outset; hence, it is called supervised learning. There are two main categories of this ML approach: classification, where the output values are categorical, and regression, where the output values are numerical (Badillo et al., 2020). Classification will be discussed in more detail below, as it is the category on which all empirical work in this research is based.

Figure 31. Supervised learning



Note. Data source: (Panarin, 2024)

If the output takes on specific values that match the labels of the input classes, the relationship between the input features and the output helps in sorting the input data. If the output takes on non-specific values, it leads to the regression of the input data. If the output assumes non-discrete values, it results in the regression of the input data (Liu & Wu, 2012). Supervised learning presents numerous advantages, the most notable being that this machine learning methodology depends on goal classes that are readily comprehensible to humans. This type of ML offers several benefits, including (Grammarly, 2024; Rashid, 2023):

- Tend to have higher accuracy and performance than other types of ML. Given that the data is structured and labelled, the algorithms learn existing relationships between input features and output more easily, thus making more accurate predictions.
- Is an ML category characterized by explicit aims since the model is trained on labelled data, where both input features and outcomes are defined.
- Generate interpretable models that enhance transparency by enabling users to comprehend how input features have affected the predictions made. This potentially increases confidence in the model's results and also facilitates the process of debugging and continuous improvement.
- Is supported by a large number of tools and libraries, such as TensorFlow, PyTorch, etc., that enable advanced functionalities for training and validating various models. Being a widely used type of ML, it also has community support and documentation.

Although supervised learning offers a number of advantages, it also has limitations related to data privacy, the need for labelled data, scalability, etc. The main issues identified are (DigitalDefynd, 2024):

- The requirement for labelled data can lead to challenges, such as the need for expertise, time consumption, and manual labelling, despite the benefits it offers in terms of model accuracy and predictions. Furthermore, these models can make predictions with high accuracy if the real data matches the data on which the model was trained. On the contrary, the model has difficulty adapting and performing properly.
- Dependence on feature engineering: selecting the right features plays a key role in generating accurate and effective models. If the selection is wrong, the performance and scalability of the model will be low.
- Data privacy concerns arise from the collection and processing of personal data, necessitating complex techniques that comply with the General Data Protection Regulation (GDPR).

Despite these challenges, supervised learning is extensively used across many industries due to its numerous advantages, such as disease detection in healthcare, fraud identification and transaction management in finance, image classification, spam filtering, and more.

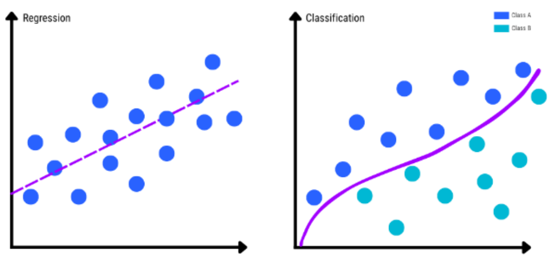
4.1.2 Classification and its core applications

Classification is a supervised learning method in which a model uses algorithms to predict the correct label for input data. It refers to a predictive process that aims to identify labels for new unknown data based on training data (Belcic, 2024). An ML model learns to predict or make decisions using training data, which provides the algorithm with some sample data from which it can learn about the relationships that exist between input data features and the desired output (in supervised learning) or the hidden structure of the data (in unsupervised learning) (Hansen, 2024). The model's performance is evaluated on data known as test data after training. Only in this way is the model able to function correctly even on new real-world data. The test data is usually different from the training data to ensure that the model will function with high performance even on new data that it comes across without knowing it in advance (GeeksforGeeks, 2023). Until the performance evaluation is done, this data is kept hidden from the model, to ensure that the model will not learn from the test data, avoiding the possibility of the model giving useless results. These concepts will be further expanded to the ML and NLP pipeline. As mentioned, supervised learning is divided into two main techniques, which are classification and regression. The difference between it and regression lies in two main factors (Simplilearn, 2022):

1. Nature of output – Both models use supervised learning, which means they require labelled data. But the difference lies precisely in the nature of the results they work with. Classification works on discrete, categorized results, while regression works on continuous values, such as temperature.

2. The main objective – Classification seeks to identify borders that differentiate classes, whereas regression endeavors to determine the optimal values represented by a line for predicting numerical data. The regression line illustrates the link between dependent and independent variables in the data, facilitating the prediction of continuous numerical values. Graphic 3 illustrates the difference between classification and regression tasks in ML.

Graphic 3. Classification vs Régression in ML



Note. Data source : (PI.EXCHANGE, 2023)

In addition, the classification models are valuable in analyzing various statistical data due to their recursive nature and flexibility in being applied to structured or unstructured data (Alnuaimi & Albaldawi, 2024). These models are used to categorize, identify patterns in data, and make predictions. Finding application in many aspects, such as:

- Email automation and spam filtering through metadata, email content and sender information.
- Financial accuracy by automating various operations within financial transactions. Enhancing transparency through the automation of various operations in these transactions ensures compliance with regulatory bodies and improves efficiency in important processes (Gao et al., 2024).
- Social media optimization by generating dedicated content through automated digital marketing strategies with ML. Classification enables sentiment analysis that provides valuable insights for businesses, organizations, and citizens by categorizing posts, comments, and

interactions on various issues (Talaat, 2023). In this way, classification models significantly impact the improvement of user experience on social media platforms.

- Healthcare advancement involves detecting diseases at early stages, diagnosing complex diseases, and monitoring the health of patients with health issues, particularly those with chronic conditions (An et al., 2023). In this sensitive and important field, classification models are trained on data such as images, genetic information, clinical reports, laboratory results, etc. These models can be trained on various medical images, such as X-rays, patient characteristics, medical history and genetics, to diagnose and determine the most appropriate treatment for patients.

Since classification serves as a concept on which many other ML techniques are based, it finds application in various ML fields such as computer vision, NLP, DL, etc. Therefore, it is important to understand the basic techniques on which classification is based including complex management of massive amounts of data, sensitivity to noise, significantly facilitating the process of extracting valuable knowledge (Alnuaimi & Albaldawi, 2024).

4.1.3 Classification algorithms

ML algorithms organize, process, and understand massive and complex data. Among them are classification algorithms, which are essential for categorizing data and making predictions. The empirical part of this research implemented some of the key classification algorithms listed below:

- Logistic Regression
- Decision Tree
- Random Forest
- Support Vector Machine
- Naive Bayes

Logistic Regression (LR)

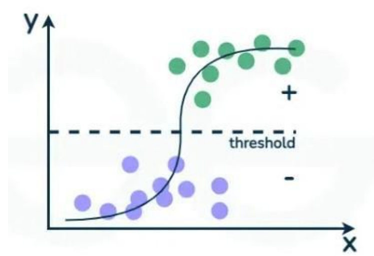
LR is a classification algorithm used to classify discrete data, usually binary data (0 or 1, yes or no). This algorithm determines the boundary that exists between classes and states that the probability that an instance belongs to a particular class depends on its distance from the boundary (Kanade, 2022). LR is a statistical method that employs the sigmoid function to execute its operations. The sigmoid function is essentially a mathematical function called a logistic function, which attributes to each real number a corresponding number between 0 and 1, according to the following logic:

$$\sigma = \frac{1}{1+e^{-x}} \quad \text{(I)}$$

where x is the input value and e is Euler's number (≈2.718≈2.718)

The LR process is depicted in Graphic 4, which illustrates an S-shaped curve defined by the aforementioned formula.

Graphic 4. Logistic regression in classification



Note. Data source: (GeeksforGeeks, 2025b)

Since this algorithm analyses the relationship that exists between one or more independent variables and classifies them into predefined classes, it makes it very suitable for predictive modelling. The generated model estimates the probability that an instance is part of a category or not. As illustrated in the graph, these models usually set a default threshold of 0.5, indicating that if the result of the sigmoid function for an instance is greater than the specified threshold, the output is considered to be 1. If not, we classify the output as class 0. For example, if this value is 0.73, the probability that the given event will occur is 73%.

Although this model generates results in the form of probabilities, it is still considered a classification algorithm because it divides these probabilities into a range between 0 and 1, which can ultimately be interpreted as probabilities of being part of a class or not.

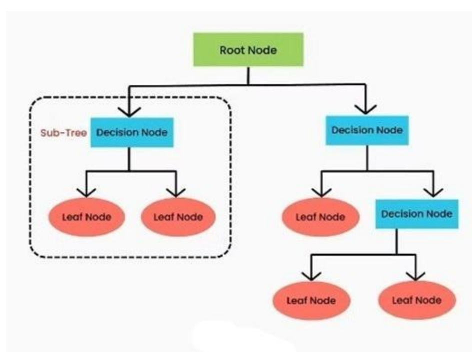
Logistic regression's main drawbacks are that it is suitable only for binary predictions and assumes that the data is complete and the predictors are independent (Wasem, 2024). However, due to its simplicity in implementation, efficiency in data processing, and flexibility for working with new data, this approach is very useful in various fields. This algorithm is widely used in predicting weather conditions, predicting risks for various diseases, word classification, and system engineering, among others.

Decision Tree (DT)

DT is a supervised learning technique shown as a diagram that delineates many choices and their potential outcomes, facilitating more straightforward decision-making. The name itself indicates that these choices and their results are organized hierarchically, with each instance classified by its religious values (IBM, 2021a). The tree, as shown in Figure 32, has nodes that represent an attribute/ feature of an instance to be classified, and each branch represents a value that the node can assume (Akinsola, 2017). Decision trees can manage and process even very complex data by dividing it into more manageable parts, and this makes them very useful in data analytics and ML. Their hierarchical structure has three main types of nodes known as (Hillier, 2023):

- Chance node: A circle in the flowchart; represents the probability that a certain result generated by the algorithm will occur.
- Decision node: A square in the flowchart; represents a decision.
- End node: a triangle in the flowchart; represents the final result of a decision path.

Figure 32. Decision tree



Note. Data source: (Turing, 2022)

A dataset can generate different trees in any number of combinations between nodes and branches to create structures of varying complexity. The goal is to create a high-performance model that can accurately predict a target variable just by training on the available data. Through these tree-shaped structures, the decision-making process is much simpler because complex data is organized in understandable forms for individuals or organizations who, using those trees, are able to assess the costs, benefits, and probability of their future decisions. The advantages of decision trees include (Newman, 2024):

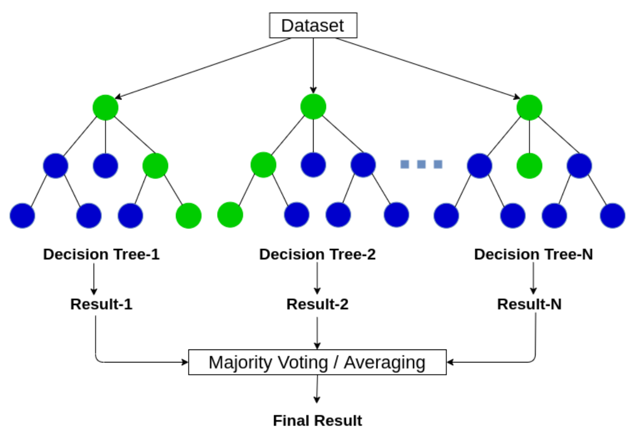
- Interpretability: The hierarchical structure of the algorithm's results renders them comprehensible and interpretable, even for individuals lacking expertise in the field of ML.
- Management of different types of data: This algorithm effectively manages both numerical and non-numerical data, which makes it highly suitable for various datasets and significantly eases the processes of data preprocessing and analysis. This advantage is because a decision tree requires minimal data cleaning before use.
- Computational efficiency: DT require much less time and memory for data processing than other supervised learning models.
- Scalability: since these algorithms usually have low complexity, they are easier than other algorithms to train on more complex and large datasets. If this process is well managed using some ML techniques, such as parallelization, it is possible that the suitability of the decision tree for completely new datasets is high (Attard, 2023).
- Practical assessment of feature importance in decision making: since the results of ML algorithms are directly related to input features, it is essential to understand which are the most important features that impact the final decisions. In DT, this process is possible due to the use of several ML techniques, such as splitting, which uses mathematical operations to determine the impact of features on predictions.

DT typically face challenges such as overfitting, dataset imbalance, and continuous variables. Overfitting occurs when the complexity of the trees increases too much, causing the model to not predict the data properly and capture some unimportant details. This condition leads to models that are not efficient at detecting existing patterns, making them unable to function effectively on new, unknown data (GeeksforGeeks, 2024b). On the other hand, dataset imbalance refers to the case when, in a dataset, the number of instances belonging to one class has a substantial difference with the number of instances belonging to other classes. This introduces a series of complex problems to ML algorithms, which is why splitting criteria are used in decision trees. According to Alnuaimi (2024) another limitation of DT is the fact that this algorithm requires a large amount of data to generate highly accurate results. However, the decision tree algorithm, due to the potential it offers in generating predictive models and its high interpretability, is widely used in healthcare, finance, customer service, human resources, etc.

Random Forest (RF)

RF is an ML algorithm that functions as a group of decision trees to make predictions. It is a widely used algorithm in both classification and regression tasks. As a very powerful ML technique, it can combine the results of multiple decision trees and then evaluate them by applying an average to them to arrive at a single output (IBM, 2021b). This algorithm creates a set of decision trees to obtain a single, most accurate result. It is one of the most popular algorithms because it is simple and suitable for various classical or regression tasks. The bagging method, which primarily focusses on reducing the concept of overfitting, is the training method for this algorithm. In this method, the learning process in the training phase is iterative, and each model is trained on the errors of the previous model using a slightly different subset than that in order to take into account all cases while minimizing errors (Alhamid, 2025).

Graphic 5. Random Forest



Note. Data source: (Sharma, 2020)

Although the RF algorithm combines multiple decision trees (Graphic 5) to generate the most accurate result, there are significant differences in how they work in the real world. According to Talari (2022), these differences include:

- The main benefit of DT is that they are easy to understand, while RF models are more complicated because you have to figure out how many decision trees to use and which variables to include in each tree before building the model. Increasing the number of trees can improve how well the model works, but it also makes the process slower and takes more time. An increase in the number of created trees enhances model performance; however, this results in time inefficiency and process deceleration.

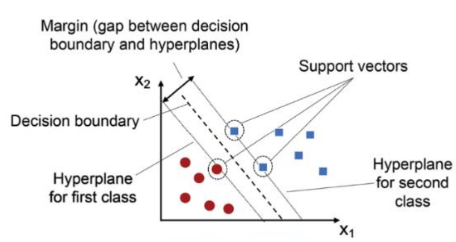
- The most significant difference lies in the fact that DT are hierarchical structures that illustrate all possible outcomes in probabilistic form, while RF has as its output a set of decision trees.
- RF algorithms are more widely used than decision trees because they are more accurate and in real life require working with massive and complex data.
- A DT model has a simple visualization to understand and adapts quickly to the dataset, while a RF has a complex visualization.
- In DT models, there is a greater chance of overfitting occurring than in random forest models.

There are a number of advantages and disadvantages of the RF algorithm versus the DT, and due to the fact that both algorithms belong to supervised learning, several factors must be considered to determine which is more suitable for use in certain situations. Sharma (2020) asserts that RF are appropriate when high accuracy is essential, effective generalization to new data is needed, and complicated data and extensive datasets are managed. If the dataset is limited and model interpretability is paramount, the decision tree technique should be employed.

Support Vector Machine (SVM)

SVM is an ML algorithm that belongs to the category of supervised learning. As a supervised learning algorithm, it is suitable for regression but mainly for classification. SVMs are algorithms designed primarily for binary classification, but as the complexity of classification problems increases, several auxiliary mechanisms can be used in SVMs to perform multi-class classifications. As illustrated in Figure 33, the algorithm aims to find the best line or hyperplane to divide the data into groups, increasing the distance between the closest points of each group created with the hyperplane (Anshul, 2021). Each object to be classified is represented as a point in an n-dimensional space, and the coordinates of these points are called features. SVM classifies data by creating a hyperplane, which acts as a dividing line in 2D or 3D, ensuring that all points of one category are on one side and all points of the other category are on the other side.

Figure 33. Support Vector Machine (SVM) algorithm



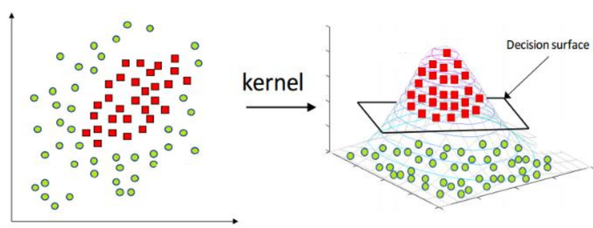
Note. Data source: (Kumar, 2023)

There may be several hyperplanes within the data, so the algorithm selects the one that best separates the two categories. The best hyperplane is considered the one that maximises the distance of the points of each category to the hyperplane (Akinsola, 2017). This distance is called the margin, and the points that correspond exactly in this area are called supporting vectors (Soofi & Awan, 2017). These data are the most difficult to classify and determine which hyperplane will be chosen by the algorithm. Maximizing the margin increases the likelihood of accurately classifying data points. To find this hyperplane, the algorithm, like any other ML algorithm, must be trained on data, and like a supervised learning algorithm, this data must be labelled. To summarize, SVM uses three main steps to classify data:

1 Creates all possible hyperplanes
2 Compares the margins created by hyperplanes with data points and selects the one with the largest margin.
3 The algorithm generates forecasts of new data points according to their placement within the plan.

All these steps occur considering that in a one-dimensional space, the hyperplane is a point; in 2D, it is a line that separates data points into two different classes; and in 3D, it is a surface that divides the space into two parts. However, complex cases arise when a straight line (hyperplane) cannot separate data points into different classes. This is the nonlinear type of SVM. In this type, the algorithm applies some additional functions, called kernel functions, to make an implicit connection over the data points in an n-dimensional space, where a suitable hyperplane can be found. Graphic 6 illustrates the kernel function in a nonlinear SVM. Despite being more complex in nature than linear SVM, nonlinear SVM manages to manage complex cases more effectively and with higher classification accuracy (TechTarget, 2024).

Graphic 6. Kernel function in a nonlinear SVM



Note. Data source: (Nimmaturi, 2019)

The biggest advantage of SVMs is that they are simple to understand and implement. Furthermore, they are effective when the size of the training data is small. One of its limitations is the fact that it does not generate probabilistic data as output, which complicates comprehension of the model (Alnuaimi & Albaldawi, 2024). However, these algorithms find use in many disciplines such as NLP, image recognition, signal processing applications, healthcare, facial classification, stenography detection, etc.

Naïve Bayes (NB)

NB is an algorithm that belongs to supervised learning, meaning that it works with labelled data (Ray, 2017). It is one of the most widely used algorithms in ML and AI, mainly in tasks related to classification. Starting from a basic theorem and assumption, the algorithm manages to classify data with high accuracy. The assumption that lies at its core is considered quite naive, and this is the reason why it got this name. Naïve Bayes assumes that all features comprising the data are independent of one another, a condition that is often not true in real-world scenarios (Cadili, 2024). The problems that the world faces today, due to the production of massive data on a daily basis, are very complex, and consequently, there are factors/attributes that are interconnected with each other. And it is precisely the relationship of this data that then creates the opportunity for predictive models and in-depth analysis through ML. However, the algorithm is widely used because of its high performance in data analysis. Bayes' theorem deals with the concept of probability and helps in calculating the probability of an event occurring, based on the probability of the occurrence of a related event. This mathematical formula, which determines the conditional probability of an event, is as follows (Hayes et al., 2025):

$$\mathrm{P(A|B)}=\frac{P(A\cap B)}{P(B)}=\frac{P(A)xP(B|A)}{P(B)} \quad \text{(II)}$$

where:

$P(A)$ - is the prior probability of event A

$P(B)$ - is the prior probability of event B

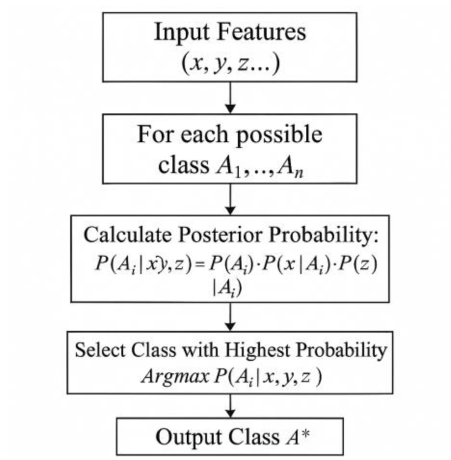
$P(A|B)$ - The conditional probability of A, given that B has already occurred

$P(B|A)$ - The conditional probability of B, given that A has already occurred

$P(A\cap B)$) - The probability of both A and B occurring

As a probabilistic algorithm, it determines the class with the highest likelihood by utilizing Bayes' theorem for each class. Naïve Bayes operates by adhering to the following steps described in the Figure 34 (Kalra, 2023):

Figure 34. Naïve Bayes flowchart



Note. Data source: (Kalra, 2023)

- Data preprocessing by dividing the data into training and testing sets and converting the data into a suitable format to apply the algorithm.
- Calculating the prior probability of each class occurring in the training data by counting how many instances belong to this class and dividing by the total number of instances.
- The conditional probability of each feature belonging to a class is calculated separately for each feature, based on the assumptions of the algorithm. This calculation is done by dividing the number of instances in which a feature occurs by the total number of instances in this class.
- The penultimate step is to calculate the posterior probability for each class, considering the features of a new instance. For example, if features x, y, z and class A are given. To calculate the posterior probability that the class is A, given the values of features x, y, and z, the following formula is applied:

$$P(A \mid x, y, z) = P(A) \cdot P(x \mid A) \cdot P(y \mid A) \cdot P(z \mid A) \quad \text{(III)}$$

This statement can be exemplified by a straightforward scenario, such as diagnosing an illness based on three symptoms of the patient, represented as x, y, and z, with A denoting the condition. In this instance, utilizing Bayesian reasoning, we are determining the chance that the patient has disease A, given certain indicators (x, y, and z).

- The last step involves selecting the class with the highest posterior probability as the appropriate one for making predictions.

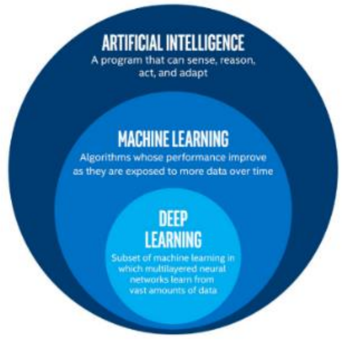
As can be seen from the steps above, this is a relatively simple algorithm, and, despite the naive assumption on which it works, it is widely used in text classification, recommendation systems, spam filtering, weather prediction, medical diagnosis, and sentimental analyses (Keylabs, 2024).

According to Alnuaimi (2024) the advantages that make this algorithm so useful are its ability to handle both continuous and discrete data while requiring less data for training than other algorithms, its ability to process data in a short time, its efficiency in the training phase, and its insensitivity to inappropriate features.

4.2 Deep Learning

DL is an evolution of ML that can autonomously learn from data, make smart decisions, and generate predictive models independently. This capability distinguishes it from ML itself, because while ML requires human intervention to learn from that data, DL uses neural networks to perform this process (Grieve, 2025). Neural networks are ML models that use advanced algorithms to understand very complex data, enabling tasks such as face recognition, natural language processing, speech recognition, etc. These models mimic the structure of the human brain by allowing information to be passed through nodes and hidden layers and sending the final result to an output layer (Abiodun et al., 2018). DL models learn continuously from data, generating results with very high accuracy, which is why they are widely used in cybersecurity, healthcare, eCommerce, entertainment, advertising, etc. As a branch of ML and AI, it is considered a core technology of today's Fourth Industrial Revolution due to the major transformations it has brought to all fields (Sarker, 2021).

Figure 35. DL in ML and AI



Note. Data source: (Balodi, 2020)

It is a pivotal technology that seeks to realize the AI goal of developing fully autonomous systems capable of attaining intelligence surpassing that of humans (Ślusarczyk, 2018). As per Abulwafa (2022), this category of ML mostly comprises a collection of classifiers that collaborate and operate using LR principles, where the only difference lies in the number of neuron nodes. As illustrated in the figure above, DL and ML both belong to AI, but they have differences in the way they learn from data, feature handling, etc. Therefore, to better understand DL, it is necessary to reflect on some of these differences. Table 5 illustrates these differences (Anaconda, 2024).

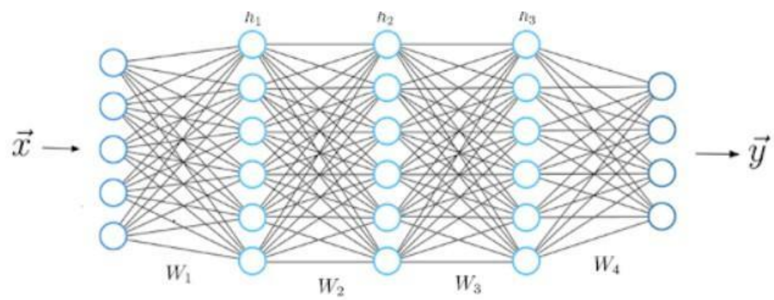
Table 5. ML and DL differences

Human touch: ML mechanisms often require human intervention in the selection of the most appropriate features and in the final model. DL executes these procedures autonomously and automatically.
Training process: ML models, due to their simpler architecture and smaller number of parameters, are usually trained faster than DL models. DL models have more complex structures and more parameters that need to be considered during the training phase.
Data requirements: The primary distinction between ML and DL resides in their varying data needs for producing accurate, high-performance models. ML algorithms can attain optimal performance with relatively small datasets, whereas DL necessitates extensive datasets to obtain similar performance.
Algorithms' complexity: DL algorithms are more complex than ML ones because they involve training many parameters in multiple layers.
Computational infrastructure and processing capabilities: ML algorithms require less processing power because they typically work on datasets of normal data size and complexity. DL necessitates extensive computational capabilities and a more advanced infrastructure for optimal performance.

4.2.1 How Deep Learning works

DL algorithms use several structures that mimic the human brain to draw conclusions, as a human would, based on a given logic. During the training phase, these algorithms manage to organize objects, extract features, and discover hidden patterns in the data (Abulwafa, 2022). The basic structures on which DL algorithms operate are called neural networks and are composed of many layers and nodes, or neurons, that transmit and process information (Oppermann, 2023). When the model encounters new data, it compares it to the objects it has trained on.

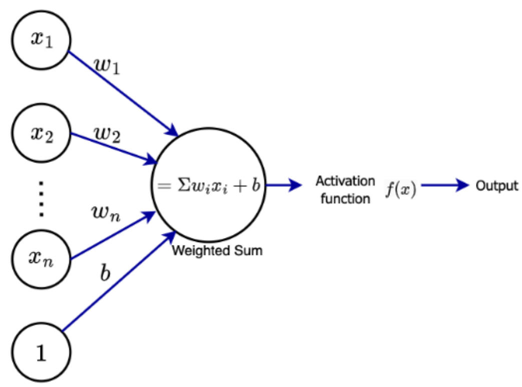
Figure 36. Neural Network



Note. Data source: (Oppermann, 2023)

In Figure 36, a typical neural network is illustrated, which has several main layers: an input layer that receives input data, one or more hidden layers, and an output layer that produces the final result (Metana, 2023). Each of the neurons has a specific mathematical function that it applies to the input data and passes the result to the subsequent layer.

Figure 37. Activation function



Note. Data source: (Intuitive Tutorials, n.d.)

These are called activation functions, and they determine whether the input to a neuron is important to the process by performing some mathematical operations, as in Figure 37. Therefore, it determines whether a neuron should be activated or not. Due to their complexity, these functions operate in hidden layers, passing the calculations to the output layer. According to Baheti (2021), almost all hidden layers apply the same activation function, but the final result depends on the choice of the output layer, which uses a different activation function. There are different types of activation functions such as Logistic Sigmoid, Tanh, ReLU etc. These functions introduce non-linearity into the model, increasing the neural network's capacity to learn from complex data and perform optimally (Dubey et al., 2022). This is how the entire network functions until it reaches the last layer, where the classification or predictive model is generated.

4.2.2 Deep Learning classification algorithms

- Multilayer Perceptron (MLP)
- Convolutional Neural Network (CNN)

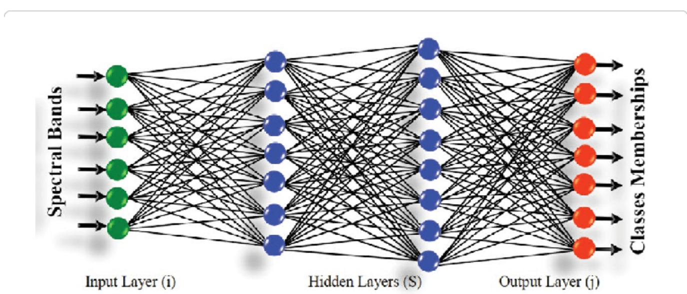
Multilayer Perceptron (MLP)

MLP is an ML algorithm that belongs to supervised learning. From the name itself it is understood that there are several layers of perceptron, where the perceptron is an artificial neuron of the network. As a highly sophisticated algorithm that aims to discover patterns in complex data, it serves for regression and classification tasks (Abulwafa, 2022). Being part of DL, it works based on neural networks and a series of layers of neurons where each layer is fully connected to the next layer, as illustrated in Figure 38. These layers comprise interconnected neurons, arranged into an input layer, one or more hidden layers, and an output layer. There are several fundamental concepts that are very important to understand in DL so that each of its algorithms can be easily used to perform various classification or regression tasks.

<u>Back propagation technique</u>

Back propagation is a process in which data passes from the input layer to hidden layers and finally to the output layer (IBM, 2024). The data travels through the layers and is transformed based on the concept of weights, biases and activation functions.

Figure 38. MLP algorithm



Note. Data source: (Serwa, 2017)

The concept of weights is related to the strength of the connection that exists between the neurons of the network. Biases define some extra parameters that guide the activation functions within the network to increase its flexibility. Activation functions, as mentioned above, are nothing more than mathematical functions that are applied to the weighted sum of the inputs at each neuron. Weighted sum is calculated as following the formula (DataCamp, 2025):

$$Weighted\ Sum = \sum_{i=1}^{n} (w_i \cdot x_i) + b \quad \text{(VI)}$$

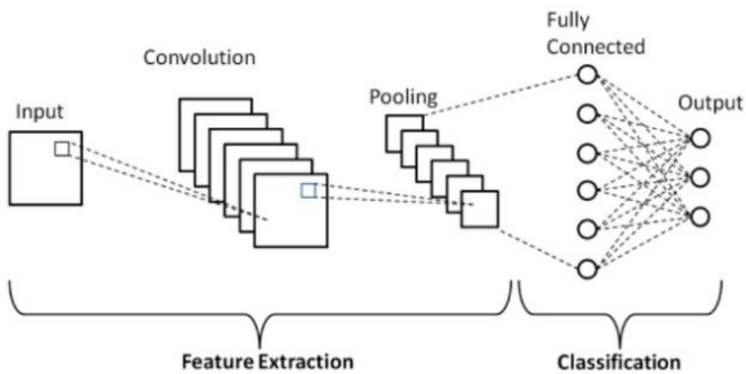
Where, n is the total number of neuron connections, w_i is the weight for the i-th input, and x_i is the i-th input value. This whole process where weights, biases and activation functions are applied to the data coming into the input layer to generate the most accurate output is considered backpropagation. In essence, this algorithm trains neural networks to learn from their mistakes by adjusting the weights for improvement. This is very necessary because it happens that the result may have been generated with errors. The error output is calculated as the difference between the actual output and that of the network, and this difference is known as the loss function (Piccioni Costa et al., 2023). And in order for the network to improve its performance, forward propagation occurs, and the error is distributed to each of the neurons of the network through an attribute that corresponds to the contribution of each of the neurons to the total error. In conclusion, this procedure is an optimization process that aims to minimize errors.

MLP is an algorithm that requires consideration of various hyperparameters, including the number of hidden layers, iterations, neurons, and interconnections, rendering it complex due to the extensive calculations involved. Determining the correct number of neurons, hidden layers, and other parameters presents a significant problem, necessitating numerous experiments before the final model generation. However, its efficiency in identifying very complex patterns in data makes it a very useful algorithm in image and speech recognition, NLP, time series forecasting, etc.

Convolutional Neural Network (CNN)

A CNN is a form of DL that is mainly used in analyzing visual data, such as images and tasks that deal with video-type data (Gillis, 2024). It is specialized for pattern recognition and therefore is very efficient in identifying different models or objects, which is why they are also widely used for computer vision tasks. The ability to identify essential features in data without the need for human intervention makes this algorithm much more important than a traditional neural network. CNN is an algorithm that, based on the dimension of the data it works with and the operations it applies to it, is categorized into one-dimensional (1D-CNN), two-dimensional (2D-CNN), and three-dimensional (3D-CNN). 1D-CNN is used when the input data is sequential, while 2D-CNN is used when the data is in two-dimensional form, such as images or tasks related to object recognition or computer vision tasks, as illustrated in Figure 39 (Kiranyaz et al., 2021). While 3D-CNN is a more complicated variant of CNN which is used when the data is spatial or temporal information (Shah et al., 2022). It is mainly used in video-type data, in medical images, etc. The following sections provide a detailed description of the functions applied to the data.

Figure 39. CNN-2D in image processing



Note. Data source: (Phung & Rhee, 2019)

CNN is a DL technique that uses neural networks, in which every node or neuron is connected to every other neuron layer by layer. However, in the case of CNN, its unique characteristic is that it uses filters to help identify patterns in the data precisely. These filters are essentially matrices that carry out pattern recognition one step at a time. The 'kernel size' refers to the filter's dimensions. The step by which the filter moves through the neural network is known as the 'stride'. In short, stride is the amount by which the filter moves at each step in the convolution . The main concepts that make up the CNN algorithm are:

Convolutional operations and convolutional layers

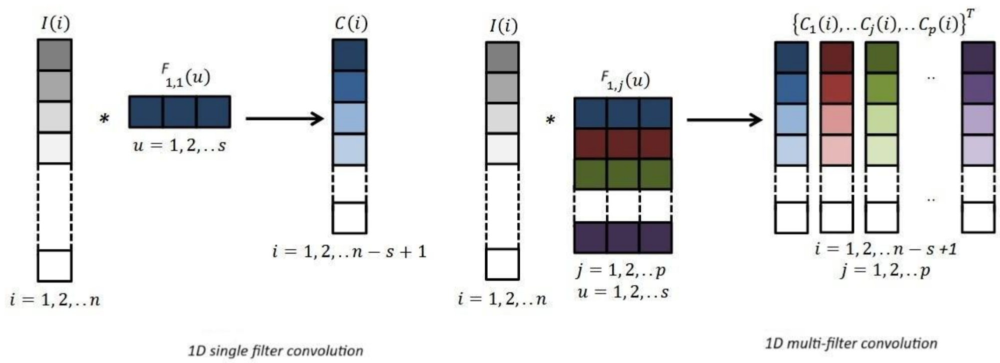
Convolutional operations are mathematical operations that are based on the layers of the CNN algorithm. With the name "convolutional neural network," it is understood that the algorithm uses a linear mathematical operation called convolution, which, through the displacement of the filter on the input data, performs the following calculations (Choudhari, 2020).

In the case of CNN-1D, the convolution operation consists of shifting the filter (F) on the input data (I). This function can be represented by the following formula (Cacciari & Ranfagni, 2024):

$$C(i) = \sum_{u=1}^{s} I(i + u - 1)F(u) \quad \text{(IX)}$$

In this context, I represents the sequential input, which may consist of text, wave sequences, etc., and has a length of n; F denotes the filter of length s; and i indicates the location at which the convolution result is computed.

Figure 40. 1D-CNN with one and multiple filters



Note. Data source: (Cacciari & Ranfagni, 2024)

Figure 40 illustrates the operation of a 1D CNN with one filter and multiple filters. So, the whole process consists of sliding the filters in the input data and applying convolutional operations on them, producing as output a new matrix called a 'feature map' or 'activation map', which performs pattern recognition. The same filter is applied to different parts of the input, allowing it to efficiently detect different patterns in the data regardless of where they occur. Since neural networks themselves contain a series of layers, at the end of each operation, the extracted output is sent to subsequent layers for a higher level of abstraction and efficiency (AnalytixLabs, 2024).

<u>Pooling layers</u>

The pooling layer in the CNN algorithm constitutes a crucial layer in which the dimensionality reduction of the data occurs while preserving the critical information necessary for analysis and the generation of predictive models. This layer functions to reduce the size of feature maps by moving a one-dimensional window over each generated feature map and summing the values within the window at each position (Gillis, 2024).

<u>Activation Functions</u>

These functions enable the model to learn from the complex relationships present in the data by applying mathematical techniques.

Fully connected layers

Fully connected layers are layers that are used for advanced analysis for tasks related to classification or regression. Each neuron at the bottom of the CNN connects to the neurons of the subsequent layers (GeeksforGeeks, 2025a). In the convolutional layer, not every neuron is connected to the output neurons, making this layer more flexible in the learning process. According to Unzueta (2025), this layer combines features extracted from the convolutional layer and the pooling layer because each neuron is connected to the others. This density of connections allows the model to perform complex analyses.

4.3 Natural Language Processing (NLP)

NLP is a field of AI that combines several fields together, such as computer science, ML, linguistics, and language studies. It is a form of AI that deals with the interaction of computer systems with natural human language. Its goal is to help systems understand, analyze, interpret, and generate human language efficiently. Nowadays, it is widely used in text-based data processing since there are many online platforms, such as social media, where people freely express and write their thoughts, generating a huge amount of data every day, which offers great potential for study. NLP operates on data, including text and spoken language. Due to its capacity to retrieve information, several individuals may have engaged with a natural language processing system without their awareness (Oracle, 2021). Examples of these NLP systems include virtual assistants that utilize machine learning and natural language processing techniques, such as Siri, Cortana, and Alexa. Additional instances of this advanced technology utilized alongside machine learning algorithms encompass functions such as sentiment analysis, grammar verification, web searching, and automatic translation (Jim et al., 2024).

4.3.1 NLP applications

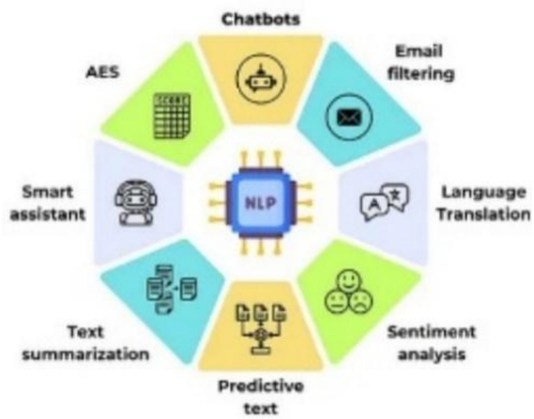
NLP has provided substantial benefits in data processing within the realm of AI. This invention has significantly influenced critical domains by providing untapped, innovative solutions. As shown in Figure 41, the primary applications of NLP include (Eastgate Software, 2024):

a. Voice Assistants and chatbots

   Chatbots and voice assistants are smart NLP applications which, according to a Statista report, are expected to surpass 8.4 billion units by 2024, exceeding the world's population

(OneAdvanced, 2023). These are applications that use a combination of ML techniques for speech recognition and NLP to understand what people are saying and aim to serve as a communication bridge between humans and the internet. Examples of voice assistants are Siri, Alexa, etc., which are widely used by people due to their ability to understand and interpret the nuance and context of sentences spoken by people. Chatbots and smart assistants can react to demands in real time and adapt to the language used by the user, enabling quick assistance and personalized experiences for people.

Figure 41. NLP applications



Note. Data source: (Medium, 2024)

b. Language Translator

One of the applications of NLP is also language translation. This technology enables not only the translation of text from one language to another in real time but can also adapt the expressed phrases belonging to one language to another, breaking any global barrier in communication. The benefits associated with this application of NLP are (Shaip, 2023):

- NLP systems can quickly understand, translate, and interpret large volumes of textual data, which reduces the costs and operational actions that would be required to perform this process using traditional methods.
- The accuracy of this functionality is high due to the combination of sophisticated ML and DL algorithms.

c. Grammar checker and predictive text

A grammar checker application is an invaluable tool for composing professional reports since it corrects spelling and grammar and provides synonyms to enhance the text's readability

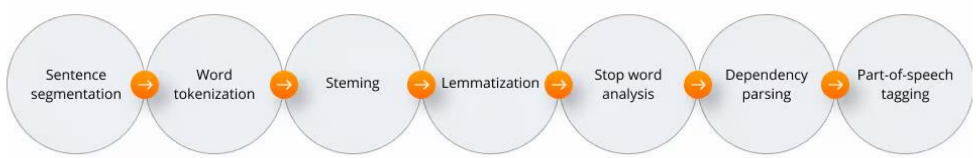
(Cano, 2024). The predictive text program focuses on automatically producing words by anticipating coherent combinations and leveraging the user's current word usage.

d. Email filtering

Email filtering is an application that, by analyzing the content, structure, and metadata of an email, enables its categorization as spam, promotion, social, or primary. ML techniques such as text preprocessing, keyword detection, NLP, and ML algorithms are used to enable this functionality.

4.3.2 ML, NLP pipeline

Figure 42. How NLP works



Note. Data source: (Szulc & Gryckza, 2023)

As a field of AI that finds many applications in discovering the relationships that exist between parts of language, such as words, phrases, sentences, and datasets, etc., there are a series of stages that consist of the following (see Figure 42) (DeepLearning.AI, 2023):

Data preprocessing

Preprocessing is a necessary step to start processing and applying algorithms to data. Since massive amounts of data are being produced every day from sensors and systems that generate data from users known as UCG systems, the data is often unstructured. This complicates their processing due to insufficient or excessive data, inherent ambiguity, and other factors. This crucial phase addresses all inadequacies or issues identified in the collected data. It enhances the result's security, clarity, and efficiency in predictive analysis (Brijith, 2023). According to Novogroder (2024), this process helps in:

- Improving data quality

Data quality management is achieved through techniques for fixing inconsistencies and arranging data in a standard format, which can lead to better generalization and model performance.

- Handling missing data

  Datasets generated by everyday systems, sensors, etc., are often incomplete, and this impacts data processing. Functions that are part of preprocessing make it possible to maintain data integrity.
- Normalizing the data

  This preprocessing technique transforms the features in a dataset so that they are all on a similar scale, e.g., between 0 and 1. This feature transformation helps in a more successful data training phase by generating higher-performing models (Saturn Cloud, 2023).
- Elimination the duplicate records

  Removing duplications in the data during the preprocessing phase makes sure that the obtained dataset contains unique records, ensuring the reliability of the results of the generated model.

The quality of the ML model directly depends on the quality of the data it works with (Medium, 2023); therefore, preprocessing must be carried out regularly according to the following stages:

I. Text cleaning

   In any ML task, text cleaning is the first step in data processing. In order for this step to be performed properly, the vision for the final objective of what should be achieved with the final model must be clear to avoid deleting data or signs that carry a meaning for the context (Rastogi, 2022). For example, in the case of performing a sentiment analysis, it is important not to remove symbolic signs from the text, such as emojis that represent a value for the context of the study being carried out. This process includes removing repeated words, correcting spelling errors, removing unnecessary spaces or punctuation marks, converting to lowercase etc. According to Shabbir (Shabbir, 2023), text cleaning phase is necessary for the following reasons:

   - It affects the improvement of data quality by generating more accurate and efficient outputs.
   - It enhances the clarity of data by making it more easily understandable for users and systems.

- Ensures that the data are well-structured for the ongoing NLP processes

II. Tokenization

Tokenization is the process of dividing a sequence of data into smaller pieces called tokens. This process helps computer systems understand natural language by breaking it down into subparts that are easier to interpret and analyze. The tokenization process helps present data in a clearer and simpler way for systems while preserving its context; therefore, it is a necessary stage to increase the understanding of the data provided.

III. Stopword removal

Stopwords are terms that do not contain any substantial meaning in the context of a phrase but nevertheless are frequently employed in written texts (Mousavi, 2025). These terms primarily function as connectors among various components of the phrase, including pronouns, adverbs, and others. Examples of such terms include ‘furthermore’, ‘in’, ‘to’, ‘and’, ‘is’, etc. Removing them during preprocessing improves the model's performance by allowing it to focus on the most important words for analysis and increasing efficiency by reducing the dataset size.

IV. Text transformation

This phase includes two very important steps for the preprocessing phase, namely, stemming and lemmatization. Stemming is a process that involves converting the words in the dataset (after tokenization) into their roots. Each word in the dataset is taken and converted into the corresponding root word so that the final analysis is as accurate as possible. This process is necessary because words take different forms within a language, and the presence of these variances within the dataset results in ineffective models (Prashant, 2021). For instance, the word ‘connect’ can take the forms ‘connected’, ‘connection’, ‘connecting’, etc. While lemmatization is the process that, after stemming suffixes have been removed from words, checks whether the remaining word is a word that exists in the dictionary or not (IBM, 2023).

Feature extraction

After the text cleaning, tokenization, stopword removal, stemming, and lemmatization phases, the phase of converting this data into a format that ML models can understand and work with must be performed. This phase is considered crucial in the performance of the output model. The step is named ‘feature extraction’ and primarily involves the reduction of data dimensionality. It encompasses multiple primary phases, including vectorization, which has its own functions, and dimensionality reduction. In this step, the data is transformed into numerical values, and after feature extraction, the selection of features follows. These two phases, feature extraction and feature selection, help increase the performance of ML models by ensuring that the model focuses on the most important aspects of the existing data (Lekkala, 2024).

Vectorization

Vectorization is an ML method that converts text data into numbers understandable to ML and DL algorithms. In the context of NLP, as we are processing text data, ML models cannot directly handle text data (Arslan, 2024). For this reason, the dataset vectorizes the words and sentences into numerical representations. The transformation is based on statistical rules and formulas which will be mentioned in the following sections. Storing words in numerical form reduces the complexity of the corpus, making it easier to process with ML models. In short, it transforms massive and complex data into a well-structured format. Furthermore, through this process the semantic meaning of the words (i.e., their context and nuances) is maximally preserved in a numerical form, making the model efficient.

a) Bag of Words (BoW)

Bag of Words (BoW) is a data conversion technique that takes into account only the presence of words and not their structure, grammatical rules, or the order in which they are written within the text. This technique is widely used in sentiment analysis or text classification due to the many libraries available for it in Python. BoW represents each of the words in the corpus in a frequency vector (Hadiuzzaman, 2025). It is a straightforward method for text vectorization that represents documents as word frequency vectors. But since this mechanism ignores the word order, grammar, and structure, it is unable to understand the semantic meaning of words and the relationships that exist between them (Brownlee, 2019).

b) TF-IDF vectorizer

TF-IDF is a new methodology for data vectorization that focuses on the importance of words within a document. It is a statistical formula that takes into account the frequency of occurrence of words in a document and how many times this word appears within all documents in the dataset (Pradeep, 2024). A document is called a ‘sentence’ in a dataset. The following formula calculates term frequency (TF):

$$\text{TF(t)} = \frac{(count(t)\ in\ D}{Total\ words\ in\ D} \quad \text{(IX)}$$

where, D stands for document and t stands for the term. During the TF calculation phase, all terms are considered to have the same importance within the dataset (Hamdaoui, 2024). But since some words in the dataset may not be very important, an inverse factor is added to increase the weight of less common terms and decrease the weight of more common terms. For example, within the dataset, the word 'the' may be repeated many times, but the term itself does not contain any value for the study. Therefore, even though the text cleaning phase removes stopwords, it is considered appropriate to also add the document inverse factor. The formula that performs this calculation, called inverse document frequency (IDF), is as follows (Somasunadaran, 2022):

$$\text{IDF(t)} = \frac{Total\ no.of\ Docs}{No.of\ docs\ containing\ the\ term\ 't'}) \quad \text{(X)}$$

The final calculation for an accurate text representation is based on a formula that equilibrates the term frequency (TF) of a specific term within the document with the inverse document frequency (IDF) of that term across a collection of documents (Hamdaoui, 2024).

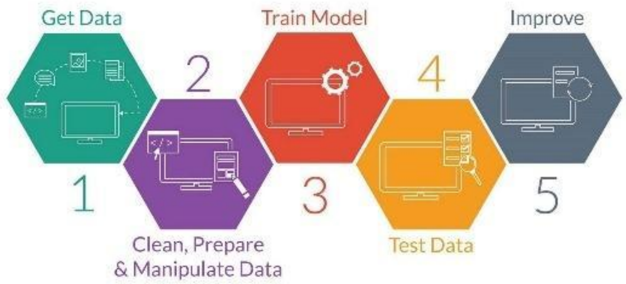
$$\text{TF-IDF} = \text{TF(t)} * \text{IDF(t)} \quad \text{(XI)}$$

In conclusion, TF-IDF vectorization makes it possible to convert each word in the dataset into a numerical value and, for each document, a vector. Thus, each word in the dataset has a corresponding vector that helps models understand the data they work with. This method is very useful for summarizing documents and reports, retrieving information, etc.

c) Word Embeddings

Word embedding is an NLP technique that aims to identify the meaning of words and the relationships that exist between them. Each word in the corpus is represented by a numerical vector, where similar words have similar vectors. These vectors are positioned in a vector space where the position of each vector represents the semantic similarities and relationships that exist between words (Barnard, 2023). It is widely used as a mechanism for sentiment analysis, text generation, machine translation, etc. (Vardhan, 2024). Unlike the TF-IDF method, that deals with the importance of words within the corpus, word embedding deals with their semantic meaning. Figure 43 illustrates ML process workflow, which is described in the sections below.

Figure 43. ML process workflow

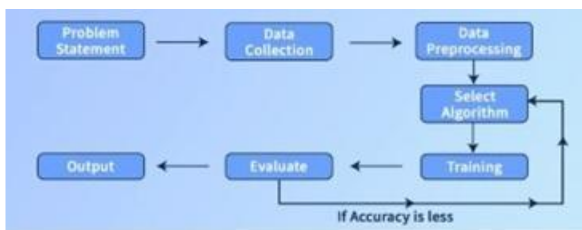


Note. Data source: (Afzal, 2022)

4.3.3 Modeling and classification

This phase includes several critical work processes to ensure a successful application of ML techniques. These processes include selecting the appropriate algorithm for the specific task and the nature of the data, splitting the dataset into training and testing subsets to generate an accurate and performant model, etc. The workflow of these steps is illustrated in Figure 44.

Figure 44. ML steps



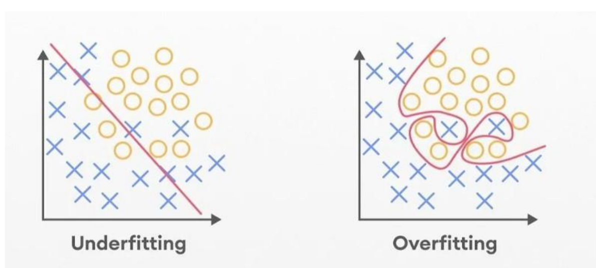
Note. Data source: (GeeksforGeeks, 2025c)

✓ **Algorithm selection**

The algorithm selection phase is very important as it affects the performance of the final model (Mayo, 2024). In order to make the right selection, we need to have a high understanding of how different ML and DL algorithms work. For example, DL algorithms are usually more complex as they work on neural networks. Each of the algorithms is suitable for performing certain tasks such as text classification, pattern recognition, text generation, etc. Applying inappropriate algorithms can lead to a series of consequences during the dataset's training. During the training phase, the model must learn from the data after it has been normalized and preprocessed. However, if the algorithm does not align with the objective defined at the beginning of the analysis, the training phase may either take longer to complete or result in an unreliable process (Oye et al., 2024). This may occur for various causes, including (Ali et al., 2023):

- The nature of the data in the dataset does not match the algorithm. Since algorithms process data and learn from it, it is essential to consider the nature of the data when selecting the right algorithm. Even the most optimal algorithms will not perform well if the way they operate does not match the type of data (Kara, 2025).
- The selected algorithm may not have the ability to properly identify and interpret the complexity that may exist among the data. This issue pertains to the concept of underfitting. Underfitting is a case that occurs when the algorithm is unable to understand the data it is working with and oversimplifies the model, leading to inaccurate outputs (Pecan, 2024). The model does not properly consider the complexity of the relationships that may exist in the data. The biggest drawback associated with this concept is the inability to perform efficient predictive analysis on new data.
- The algorithm may work very well during the training phase but does not perform well during the testing phase. Overfitting occurs when a model learns from unnecessary data in addition to the training data. This means that the model learns and memorizes the training set too well, causing it to make incorrect predictions based on new data. It occurs when the collected data does not represent real-life data or when the model is too complex (Google Developers, 2024). Figure 45 illustrates the concept of underfitting and overfitting.

Figure 45. Underfitting vs overfitting



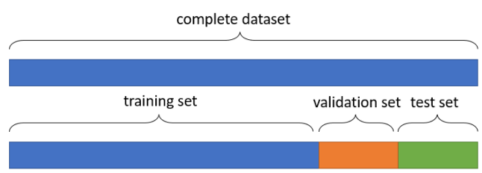
Note. Data source: (Tigran, 2022)

There are algorithms that require a lot of data to function properly, and not having enough data leads to failure of the training process and ineffective models. As a result, the generated model may not be accurate. It is mainly DL algorithms that require a large amount of data to perform well. Ensuring a sufficient amount of data for processing is the first step towards an accurate study and efficient model in predictions and analysis (Alzubaidi et al., 2023).

✓ **Data splitting**

A very important step in ML that ensures that the final model is accurate and works efficiently even on new, unknown data is to partition the dataset. To increase model performance, since the success of any ML model depends on the diversity of the data used, the data is divided into three parts, each of which is used for different purposes (see Figure 46). According to Mistry (2025), this partitioning is crucial because prevents overfitting, through the validation set, it provides an efficient way to evaluate whether the model is successful even on new data, etc.

Figure 46. Data splitting



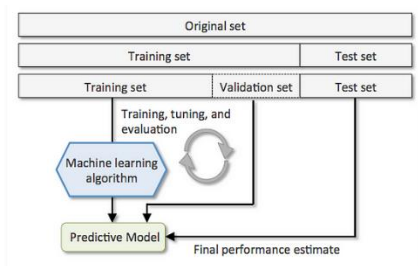
Note. Data source: (FutureLearn, n.d.)

Training set: the data that enables the model's learning process (Wizards, 2022). ML models' ability to learn from their available data is precisely related to training data. By identifying the relationships that exist between the data, the model becomes capable of predictive analysis on real-life data that are unknown to it. In this procedure, it is crucial that the data accurately reflects reality (via class balancing and authenticity) and that the training set is sufficiently large to meet the final target.

Validation set: data used to evaluate the model based on its performance on new data during the training phase. Selecting the right algorithm to generate the final model requires testing several algorithms or testing the same algorithm but with different parameters (Carty, 2025). During the data training phase, these data provide new data to the model in order to evaluate the efficacy of either the algorithm or the selected parameters. The primary function of these data is to mitigate overfitting, which occurs when the model assimilates the training data but fails to generalize to unseen data. By periodically intervening in the validation set during the training phase, it is more certain that the model will perform better on new data.

Testing set: Data used to test the performance of the model after the training phase has been fully completed. This set of data determines how capable the final ML model is of generalizing to new examples and providing accurate and reliable predictions. Figure 47 illustrates the three types of data described.

Figure 47. Data preparation process



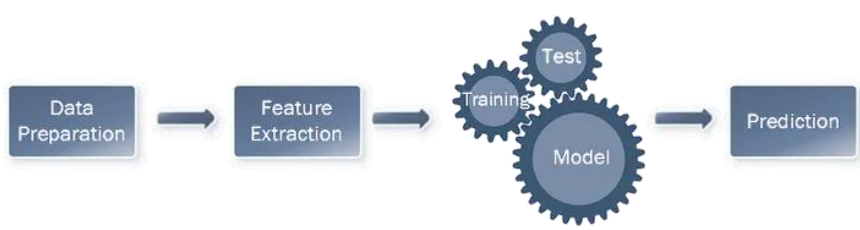
Note. Data source: (Radakovic, 2021)

It is essential to understand the role of training data, validation data, and testing data in building a successful ML model. If the training phase contains high-quality data, it impacts the accuracy of the model. The data used for validation helps prevent overfitting and select the right algorithms or parameters, while the testing phase evaluates how efficient the model is in new scenarios. According to Carty (2025), the time needed to prepare the data for processing, i.e., the phases mentioned so far, takes up about 80% of the total time for developing the final model. And this emphasizes the great importance that these steps have for the entire ML workflow.

✓ Model training

The model training phase is a crucial and indispensable part of the entire ML cycle, as it enables data analysis and the generation of predictive models. In this step, the model "learns" from its data and determines how well the model will perform once deployed by end users.

Figure 48. Model training in ML



Note. Data source: (Nemutlu, 2024)

This iterative process, as illustrated in Figure 48, involves using the preprocessed data from the methods mentioned above and feeding it into the chosen algorithm. As the model learns from the training data, it begins to improve its ability gradually to perform on unknown data. The data's quality is key to the final model's accuracy, as it determines the logic and relationships the model will learn to recognize. If the data accurately represents real-world problems, the model will perform well and generalize in future tasks.

✓ **Model evaluation**

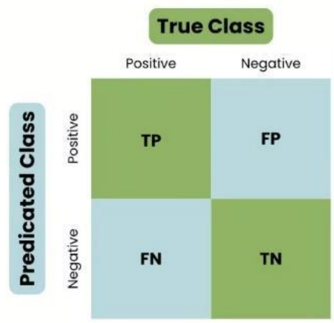
Once the model has been trained comes the phase of evaluating its performance on new unseen data, which is the data previously divided into the test set. Several analytical metrics enable the evaluation. In supervised learning, the parameters measuring the models' performance are adapted to the logic of regression and classification. This final step determines whether the generated model is reliable; is it able to make accurate predictions in new situations with unknown data, etc. Two main causes of poor model performance are usually overfitting and underfitting (Fatmanurkutlu, 2024). Addressing these two problems early in the process prevents the generation of useless models at the end. Depending on the type of problem and data, the metrics for evaluating the performance of the model vary. In supervised learning for classification tasks, the following metrics are used to evaluate performance:

a. Confusion matrix

   One form of evaluating the performance of an ML model is called a confusion matrix. A confusion matrix serves as a tool, visually illustrating a table that compares the model's predictions with the actual results. This table helps to further understand the state of the model and the areas that need improvement. The structure of the table varies depending on the number of classes to be predicted (see Figure 49). Its dimension is n x n, where n is the number of classes that are defined by labelling. The figure below specifically provides the following information:

   - True Positive (TP): This occurs when the model correctly predicts the class defined as positive.
   - True Negative (TN): When the model has correctly predicted the class that is defined as negative. So, T-true means that the prediction was true and N-negative means the class for which the prediction was made.

Figure 49. Confusion matrix structure



Note. Data source:(Jatniwalafizza, 2024)

- False Positive (FP): This occurs when the model has incorrectly predicted the positive class.
- False Negative (FN): Just like in FP, in FN the model incorrectly predicts the negative class.

b. Accuracy

Accuracy is another performance metric derived from the confusion matrix. As the name suggests, it is related to the precise accuracy of the generated model. The higher the value of this metric, the more accurately the ML model predicts cases. Specifically, it is calculated with the following formula:

$$\text{Accuracy}=\frac{Correct\ predictions}{All\ predictions} \quad \text{(XII)}$$

It is understood from the formula that accuracy measures how many times the model has predicted correctly in relation to all predictions made.

c. Precision: measures the quality of accurate predictions made by the model. So it measures how many of the predictions for the model it labeled as positive, were positive.

$$\text{Precision}=\frac{TP}{TP+FP} \quad \text{(XIII)}$$

d. Recall: calculate how many of the positive classes were correctly identified by the model.

$$\text{Recall}=\frac{TP}{TP+FN} \quad \text{(XIV)}$$

e. F1-Score: This metric provides a clearer understanding of the model's overall performance. In the calculation, it combines the two metrics mentioned above according to the given formula:

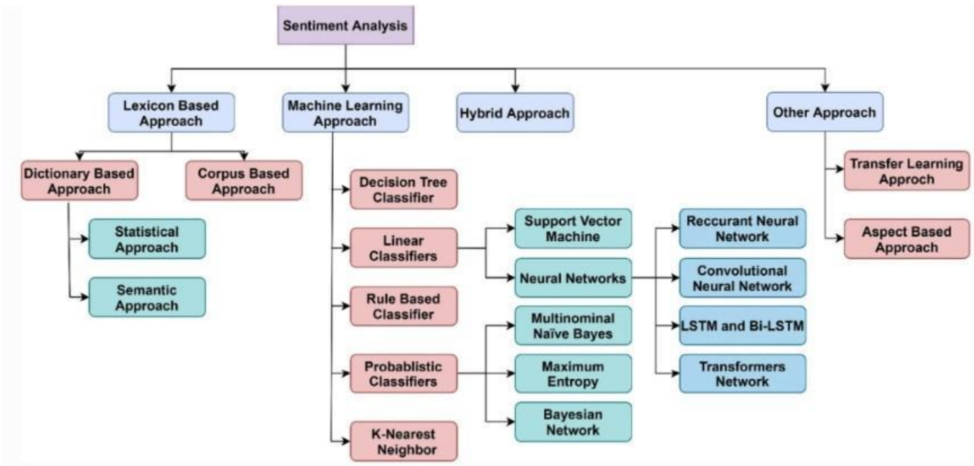
$$\text{F1-Score} = \frac{2 \cdot (Precision + Recall)}{(Precision + Recall)} \quad \text{(XV)}$$

f. ROC-AUC: is a metric that visually represents the model's ability to distinguish between negative and positive classes in a binary classifier (EvidentlyAI, 2025). In graphical form, the ROC (Receiver Operating Characteristic) illustrates how well the model distinguishes positive cases from negative ones for different levels of accuracy. The Area Under the Curve (AUC) represents the area beneath the ROC curve numerically. This value is related to the threshold concept. The threshold determines the value separating the classes from each other, usually 0.5. In this case, if the probability is above 0.5, it is classified as positive; otherwise, it is classified as negative. But the value of this threshold can also be different according to the need and the analysis to be performed. AUC takes this metric into account and calculates the area under the ROC graph, giving a single value for the model's performance. The closer this value is to 1, the more capable the model is of detecting classes from each other.

4.3.4 Sentiment analysis

Sentiment analysis is a very popular task in NLP recently. Since people widely use social networks, product/service reviews, online surveys, and online platforms to express their opinions, large amounts of data are produced. These data possess greater value and potential. It is precisely AI that enables the processing of this data and the benefit of the potential it offers in generating real-time analysis and predictive models. Analyzing the opinions expressed by citizens allows businesses to understand their real feelings regarding the products and services offered. In the case of businesses, this concept enables the improvement of customer relations and impacts the decision-making process. Sentiment analysis aims to classify expressed opinions as negative, positive or neutral by generating hidden feelings in the text. This analysis looks at the emotions and context of each comment, not just polarity. Taking into account the context of a word within a sentence makes sentiment analysis a very useful mechanism in many fields, not just businesses. The problem with the data produced every day by User Generated Content (UCG) systems lies in their unstructured nature. According to global studies, around 80% of data is unstructured, necessitating numerous meticulous preparation procedures facilitated by machine learning and deep learning techniques. Sentiment analysis can be conducted by several methods, including lexicon-based, machine learning, hybrid approaches, and others (Dilemegani, 2025). Figure 50 illustrates these strategies.

Figure 50. Sentiment classification techniques



Note. Data source: (Arslan, 2005)

In the lexicon-based method, each word is associated with a sentiment score, and the sentiment of a document is calculated as the sum of the sentiment scores of the words it contains. The method based on ML algorithms operates on labelled data and follows the standard phases of machine learning, including preprocessing, feature extraction, and the application of selected algorithms.

The most suitable algorithms for this type of method are NB, SVM, DL neural networks, etc. On the other hand, the hybrid approach of sentiment analysis combines the aforementioned methods. This method improves the accuracy and quality of analysis in texts from different fields. This approach offers numerous advantages in detecting sentiment within extensive and unstructured textual data. Notable examples include:

- The ability to detect public opinion
- Improving customer experience through data-driven decision-making
- Real-time monitoring of public reaction to products/services, various issues or undertaken projects
- Timely identification of risks and unforeseen/unincluded aspects in the policies followed or in the services/products offered, etc.
- Enables competitive analysis
- Real time decision making etc.

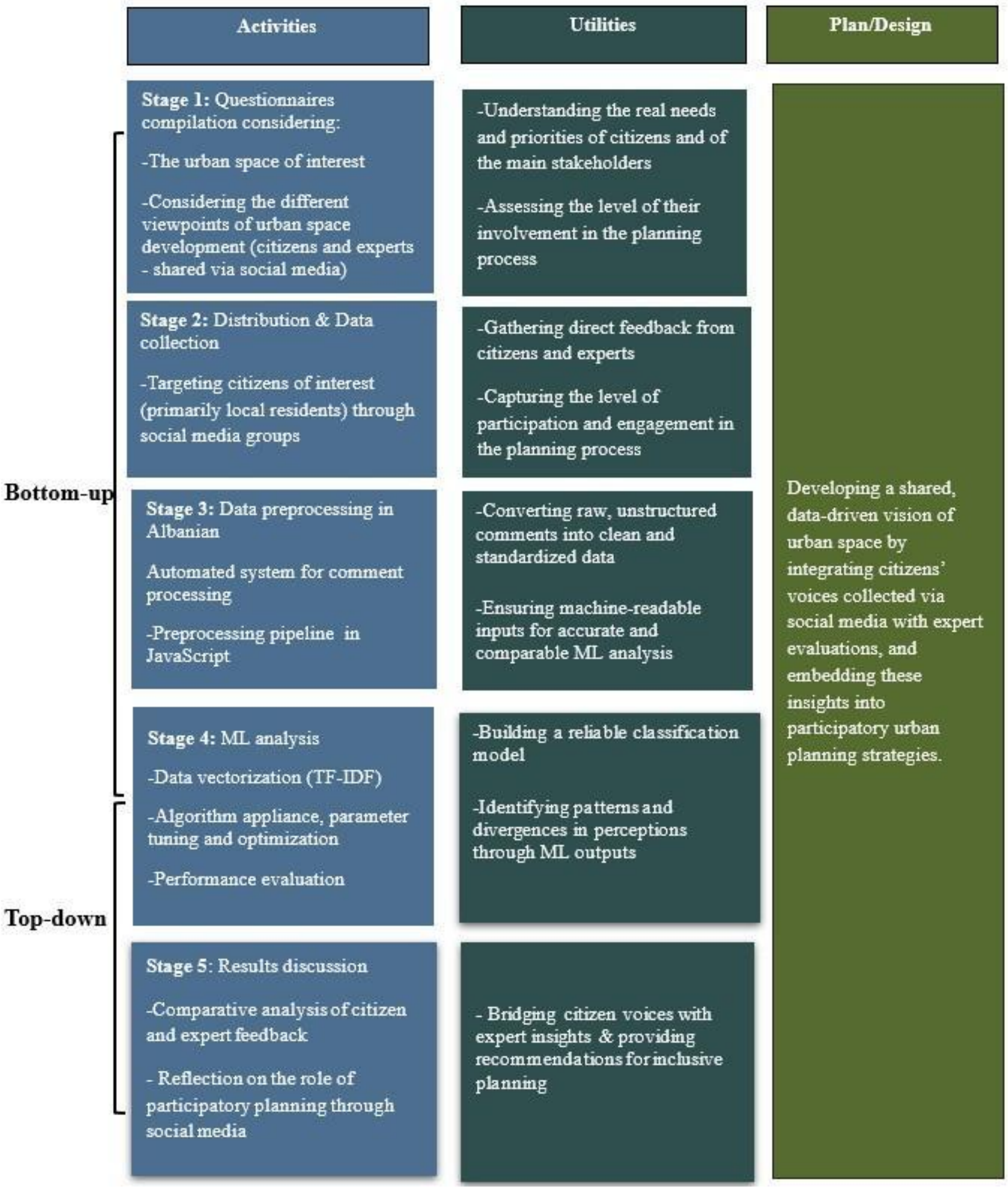
4.4 Generalized methodological framework

The methodology followed in this research, which aims to develop a participatory planning model using social media, includes a series of steps and techniques related to ML and AI. Two moments are essential in this research: the collection of the data and the data analysis. For the data collection, traditional questionaries were distributed through social media such as Facebook, Instagram, Twitter etc. It is chosen this simple data collection method based on the following reasons:

- Such a questionnaire provides information that directly responds to the problem posed in a structured form and that belongs to traditional methods of collecting people's opinions. In order to draw a deeper opinion from people, regarding also issues not covered in the questionnaire, a comment field has been added to the questionnaire where people can freely express any opinion about the issue. Using the comment field mimics receiving raw information from social media.
- The Albanian language lacks appropriate NLP libraries for comprehending, interpreting, and analyzing data within its semantic, linguistic, and morphological framework. Due to this lack, part of the data processing steps was performed with additional codes and scripts created specifically for this research. In social networks, data is usually unstructured and difficult to manage due to the lack of regular use of language grammar, the use of abbreviations, words with indirect meanings, and occasionally even writing with syntax errors.

In other languages with corresponding Python libraries, the functionality offered by those libraries easily manages this irregularity; however, in the case of the Albanian language, all these 'problems' will have to be handled manually. Maintaining a constrained vocabulary in the corpus enhances the manageability of the data acquired by ML methodologies and algorithms developed in Python and JavaScript. Figure below illustrates the research workflow.

Figure 51. Research workflow: From citizen voices on social media to expert-driven urban planning



The research has taken two different case studies in the Tirana area; the first case is more general and deals with citizens' perceptions of green spaces in Tirana. While the second case focuses on a specific construction project which has sparked a lot of public reaction. The logical flow of the methodology followed is generally the same in both cases, but since the data are different, there are small differences in preprocessing. The first case study is described briefly since it is already published, and the second case study is the focus of this research. The methodological steps described below align with the second case study in this context.

To have a clearer picture of the impact of the project in reality, it was considered necessary to obtain the opinion of citizens and experts as well. For this purpose, two different questionnaires are used incorporating demographic information, closed-ended questions, and open sections for free-text comments. These instruments are designed to capture how citizens and experts perceive their level of participation, as well as different project dimensions, including environmental aspects, housing, mobility, facilities, traffic, and related factors. The opinions of both residents and non-residents were studied separately to understand how sentiment towards the changes brought about by the project varies and how location is related to sensitivity and public opinion in this case.

4.5 Summary

This chapter discussed the ML, DL algorithms and NLP mechanisms used in the research. Considering the purpose of this research, the data analysis technique is supervised learning, and consequently, classification algorithms such as MNB, LR, CNN, MLP, RF, etc. are described. NLP, as a form of AI that deals with text-based data, involves sentiment analysis, and it is precisely this approach that has to do with the essence of this research: analysis of the opinions expressed by citizens and experts in social networks. To provide a more coherent logical flow, the chapter ends with a section that generally presents the methodological model followed. The next chapter focuses on applying these mechanisms in a specific context in Tirana; therefore, the issues addressed here provide a strong foundation for the empirical work. To sum up, it can be argued that ML, DL, and NLP serve as instruments that offer transformative potential and generate innovative solutions with practical impacts in everyday life.

CHAPTER 5 - Case Study (Tirana, Albania)

This chapter addresses the empirical part of the research. It opens with a critical analysis of citizen participation in urban planning in Tirana, followed by the discussion of the main actors (stakeholders) of this research. An important component of this chapter is the presentation of two case studies and the discussion of their relevance to the objectives of this research. The analysis is focused on the second case study, on which the empirical implementation of the subsequent phases of data analysis was carried out. Next, the ML pipeline is explained in detail, including the processes of labelling, lemmatization, comment processing, and vectorization, as well as the application of ML and DL models to the two available datasets (citizens' and experts' dataset). Finally, the algorithmic part of the empirical work carried out is graphically demonstrated and interpreted, creating opportunities for further in-depth ML analyses, which are presented in the following chapter.

5.1 Participation in Tirana: Institutional framework and critical assessment

Tirana is a typical case of a city which, in terms of urban planning, has been characterized by instability and lack of institutionality. According to the description given of Tirana's urban planning after 1990, it can be said with conviction that there was no established planning model in this city. The dynamic nature of urban issues stems from factors that are complementary to but no less important than institutionalism, including economic, social, and political factors. Here it is important to recall that the transition of the political field in two completely opposite directions led the country to a situation where informality in construction became a normal practice for citizens. This section does not aim to revisit the theoretical basis that explains the challenges faced by the entire system in Albania, as this is already covered at the end of the third chapter; instead, it aims to provide a comprehensive overview of how participation functions in Tirana. To create this panorama, it is essential to emphasize that from the imposed nature of urban policies in the past, citizens in Albania developed the concept of 'planless' planning as a form of freedom. Thus, during the communist regime, the lack of adequate housing and services led people to build indiscriminately wherever they could, resulting in a disoriented city without identity. Thus, it appears that the citizens themselves initiated the creation of new residential neighborhoods, a process that can be named as 'pseudo' bottom-up planning. But in fact, it was not such a process because it lacked rules, planning standards, and institutional approval. This chaos came more as a spontaneous reaction of citizens in the absence of an effective institutional system; therefore, it cannot be considered that there was participation. Consequently, with the aim of providing solutions to the problems created, institutions approved and implemented initiatives and projects without public consultation, completely top-down. As a result, over the years, citizens have created the perception that urban planning is a process that is entirely controlled by institutions, linking it to the past.

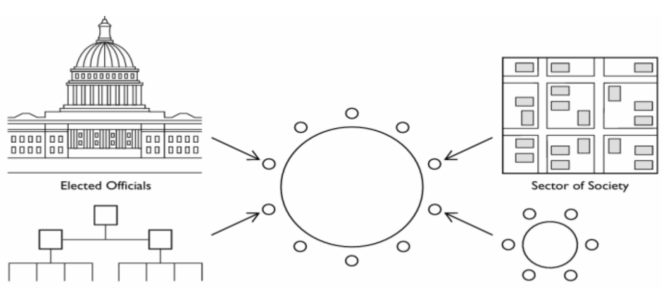
Recently, economic growth, political stabilization, and the general democratization of various processes have improved this approach; however, the democratization of the decision-making process remains problematic because there is no specific model outlining citizens' roles in these processes. In the research framework are examined how urban projects and policies are approved and the forms of participation currently applied (discussed at the end of Chapter 3), and it notes that these processes are completely rigid and lack transparency. The project approval process is procedural and complicated, with public participation occurring only through public hearings organized by institutions according to deadlines published on government platforms; however, these processes are often closed off and result in minimal participation. Furthermore, on government portals, where these dates are usually published, it is noted that these public hearings are held very rarely. Another form of participation is consultation with residents affected by the project. These consultations often serve politically to demonstrate that the principles of democratization in decision-making processes are being met, but they also have a relatively low participation rate. One of the factors for this level of participation is the fact that these participatory forms are not inclusive. But the main factor has to do with the lack of trust in the transparency of such processes. The lack of information about the policies undertaken and the failure to take into account public opinion on various urban issues have caused trust in them to decrease and resistance to change to increase. After this description, it is best understood that it is necessary for the relevant institutions to take real steps to move towards the democratization of the decision-making process. Urban planning in Tirana needs intervention to address the challenges that citizens are facing, such as heavy traffic, infrastructure in peripheral areas, etc. But this process should consist of integrating the historical, cultural and social elements that make up the urban space, with the aim of increasing a sense of belonging and identification (El Moussaoui, 2024). Historical, socio-cultural and economic factors, in addition to the transformations they have brought, have significantly influenced the formation of citizens' perceptions of the use of urban spaces. For this reason, it is necessary to take this perspective into consideration. Numerous studies have shown that involving citizens through a bottom-up approach in the planning process of their residential area has proven to be very effective, transforming the way the community approaches urban space and making it an integral part of their daily lives. One way to move in the right direction is to embrace technology, especially AI, to improve citizen-based decision-making. Social networks are a compelling tool in this regard because they are widely used by the population, and they can collect real information which, through analysis with ML algorithms, helps to understand the real needs of citizens.

This research takes as a main case study a project that has aroused a lot of public reaction due to the way it was approved and is being implemented (explained in more detail in the following sections). This project is a typical example of citizen non-participation in urban projects that affect many residents and influence the city's development, making it an important case to study. Significant reactions on social media led to the formation of community groups, which included both citizens and numerous activists and organisations. In this research, this tool is used to collect data from residents and beyond because it, above all, brings benefits in forming a sense of shared responsibility and offers outstanding potential for data analysis.

5.2 Stakeholders as key actors in participatory planning

The knowledge generated by the system created based on NLP can be useful for many parties who are interested in the city's developments. In the case study based on the division made by Margerum (Steiner & Butler, 2007), the interested parties can be categorized as follows in the Figure 52:

Figure 52. Types of stakeholders



Note. Data source: (Steiner & Butler, 2007)

Table 6. Research main stakeholders

Citizens and local communities					
Residents/ Neighborhood residents	Neighborhood businesses	Users of urban services such as parks, public spaces et	Vulnerable and marginalized groups	Landowners/ Renters	Active social media users

Organizations and interest groups			
Civil society organizations	Professional associations	Media that inform and shape public debate	Neighborhood associations and community initiatives

Institutions and decision-making bodies		
Municipality of Tirana and local units	National Agency for Territorial Planning and Urban Development	Research centers

Table 6 summarizes the major stakeholders considered in this research. To summarize, the developed system for collecting data through social media and analyzing it through ML techniques:

- ✔ It serves citizens to be involved and have a role in decision-making processes;
- ✔ It helps various organizations and interest groups to represent their interests;
- ✔ It assists urban planners and field experts in taking timely, concrete actions and drafting well-structured plans that enable institutions to make more efficient decisions addressing the actual needs and demands of citizens, thereby ensuring greater social well-being and the development of cities with a clear vision for sustainability.

5.3 Case study 1- Green spaces in Tirana

As noted in the previous chapter, two completely different approaches have been taken as case studies to develop a genuine system for involving citizens in the urban planning process. The first case examines citizens' opinions on green spaces in the Tirana area, while the second case focuses on a specific project that provides more detailed information and significant conclusions for this research.

In Tirana, green spaces are increasingly being replaced by new buildings and urban projects, which, with the aim of creating a better view of the city through modern architectural models, often override the need for green spaces. As mentioned above, this city has undergone major changes recently, and, given its history, there has been great progress towards a more sustainable city, but participatory planning remains a challenge for sustainable development.

In the first case study, the research conducted on green spaces focuses on including citizens' opinions in decisions made about their residential area or the city as a whole. Specifically, the study proposes the creation of a communication strategy with ordinary citizens in the urban planning process to be closer to their real needs and demands. The logic in both case studies is along the same lines. They use social media to distribute online questionnaires and target several interest groups for each of the selected topics. While sophisticated AI mechanisms carry out data processing, the two case studies differ in the preprocessing of the collected data. Albanian data processing has caused some technical difficulties, but most functions were automated with code written in Python, JavaScript, and other languages.

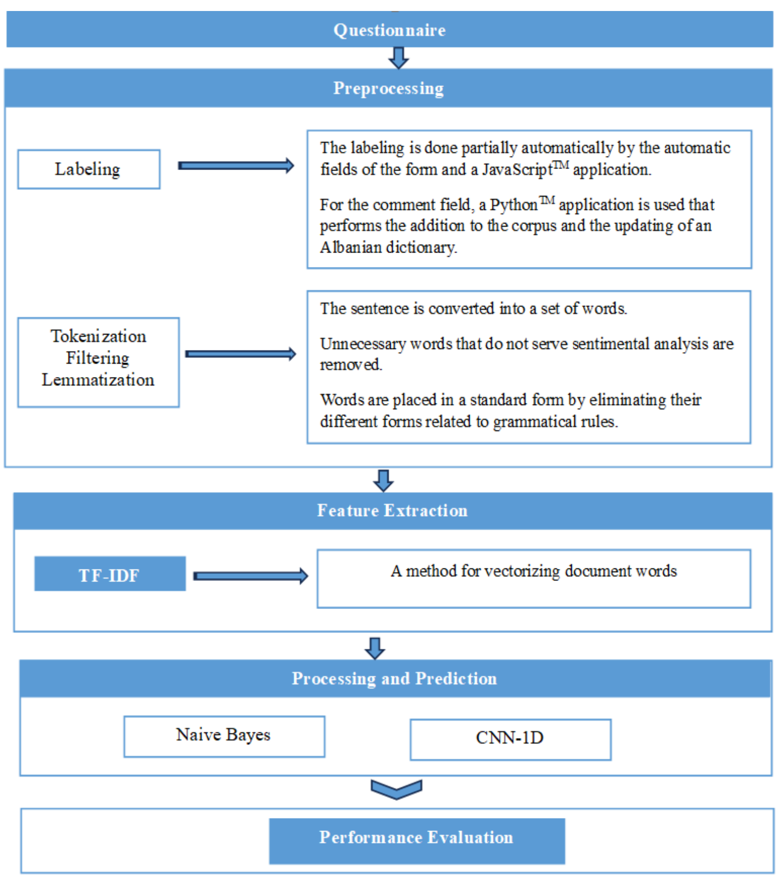
In the case of green spaces, the objective was to develop an NLP-based system to perform analysis of the opinions expressed by citizens in the online questionnaire. This study combined traditional data collection methods with contemporary ones like AI and ML. The questionnaire contained closed questions like:

i. "There is a lack of green spaces in the community."
ii. "There are enough green spaces in the community."
iii. "There are enough green spaces in the city."
iv. "Green spaces are far from the community."
v. "There are no green spaces for children."
vi. "There are green spaces only for children."
vii. "Green spaces do not have suitable paths."
viii. "Green spaces are well organized for the elderly."

The residential area was a mandatory field and is expected to be used in a future study to compare ML-generated insights with the current state of green spaces in specific locations. The questionnaire also contained an open field for citizens' comments. What makes the chosen methodology a system is the personalized processing of the comment field. Since NLP libraries that serve to understand and interpret the semantic meaning of Albanian language words are missing, some additional code was created in JavaScript and Python.

One of the developed scripts was designed to automatically extract the root forms of words contained in the citizens' comments and add them to the dictionary created from the dataset, thus creating a limited dictionary related to this issue. The manual work consisted just in completion of this dictionary for any form of the words. What distinguishes this system, which makes it a dynamic system and not just a Google form, is that <u>any free text comment outside of the pre-defined questions was added as a separate question</u>, enabling the voice of citizens to be considered step by step. Comments often highlight issues or problems that may not have been addressed in the public questionnaire. This functionality was made possible by an Python code, but also incorporated an evaluation step to determine whether each addition was valuable enough to be included. In total there were **657** records, and most of them had comments expressed in the free field. The steps followed are illustrated in Figure 53.

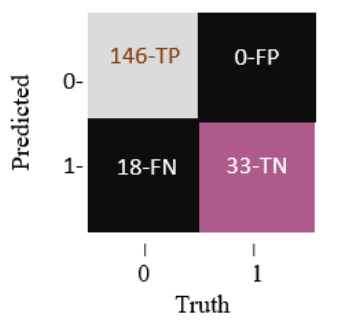
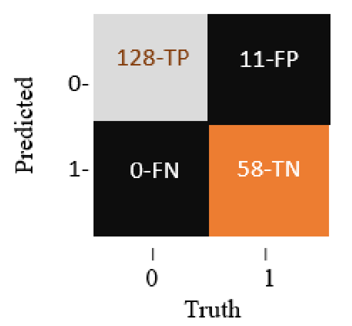
Figure 53. Study workflow



Note. Data source: (Shehu et al., 2025)

Based on the nature of the data and the objective to classify citizens' opinions through sentiment analysis, the NB and CNN algorithms were selected for implementation. Studies have shown that NB is a very effective algorithm for text classification when the TF-IDF method is used for vectorization, which represents an statistical method. Thus, the following results were obtained from the application of the algorithms:

Table 7. Case study 1 – confusion matrixes

<table>
<tr><th>NB</th><th>CNN-1D</th></tr>
<tr><td>
</td><td>
</td></tr>
</table>

- FP (1,0) - 'False Positive': the classifier predicted 'negative opinion' for actually positive opinions, just 0 in NB and 11 in CNN.
- TP (0,0) - 'True Positive': the classifier predicted 'negative opinion' for actually negative opinions, 146 in NB and 128 in CNN.
- FN (0,1) - 'False Negative': the classifier predicted 'positive opinion' for actually negative opinions, 18 in NB and 0 in CNN.
- TN (1,1) - 'True Negative': classifier predicted 'positive opinion' for actually positive opinions, 33 in NB and 58 in CNN.

To perform a more complete evaluation of the algorithm's performance, classification reports are also presented in a comparative manner, as in Table 8.

Table 8. NB and CNN-1D classification reports

Class/ Metric	Naive Bayes				CNN-1D			
	Precision	Recall	F1-score	Support	Precision	Recall	F1-score	Support
Class 0	0.89	1.00	0.94	146	01.00	0.92	0.96	139
Class 1	1.00	0.65	0.79	51	0.84	1.00	0.91	58
Accuracy			0.91	197			0.94	197
Macro avg	0.95	0.82	0.86	197	0.92	0.96	0.94	197
Weighted avg	0.92	0.91	0.90	197	0.95	0.94	0.95	197

Note. Data source: (Shehu et al., 2025)

As can be seen from the metrics above, the CNN algorithm performs better than NB, since the accuracy is at 94% and the F1-score has a high value, which indicates that there is a satisfactory balance between precision and recall (the metrics role are explained in detail in the previous chapter in section 4.3.3). In general, the model achieved over 90% accuracy, indicating that over 65% of citizens' opinions confirm the lack of green spaces in the Tirana area.

It is important to mention that, the explanation of the main steps of ML, including labelling, tokenization, filtering, lemmatization, and vectorization, is done on behalf of the Tirana Riverside Project because the case of green spaces has already been published. Choosing two different case studies illustrates the untapped potential of citizen voices in various urban issues. The Tirana Riverside Project has more detailed questions and more meaningful results than the first case, which addresses a more holistic urban issue.

5.4 Case study 2- Tirana Riverside Project

Tirana Riverside is a project in the northern area of the capital of Albania, Tirana, very close to the Tirana River. The project is the continuation of "Medrese" street and will be connected to "Bulevardi i Ri". Over the years, this area, like many others in Albania, has been characterized by irregular construction and underdeveloped infrastructure. Therefore, in 2020, this area was declared for mandatory development by Decision No. 78 of the Council of Ministers, and the project designed by architect Stefano Boeri was approved. Among other things, the project was also developed within the framework of the reconstruction process for the shelter of families who suffered damage from the 2019 earthquake. Tirana Riverside presents a deep urban regeneration through the creation of mixed social areas and functional areas that were once not in service to the public. Figure 54 shows the conceptual visualization of the plan.

Figure 54. Conceptual visualization of Tirana Riverside Project

Note. Data source: ("Tirana Riverside | Albania," n.d.)

The plan of this initiative is to provide accommodation for about 12,000 people within an area of 29 hectares, with 580,000 m² designated as construction area("Tirana Riverside | Albania," n.d.). The project commenced its works in the second half of 2021, impacting over 200 private and state properties. Hundreds of families were affected by this change(Goci & Harris-Brandts, 2025).

Residential, business, leisure, and sports facilities have been anticipated to ensure that all essential services for inhabitants are readily accessible. These amenities include numerous administrative services, educational institutions, and a university center. In addition to the facilities for citizens, another important objective is related to the development of this once unstructured space, according to European standards with a high urban quality. Furthermore, being very close to the Tirana River, a community park has been designed to preserve an ecosystem for the development and conservation of biodiversity in the urban environment. The entire 29-hectare area is designed to be divided into three main development areas, as illustrated in Figure 55:

- Public spaces that include areas dedicated to children, private home gardens, general urban gardens, etc.
- Spaces within neighborhoods include areas dedicated to various religious services for different faiths, educational centers, and sports centers.
- Larger urban spaces include the university center, a park around the Tirana River, offices, administrative services, etc.

Figure 55. Functional layout and 3D spatial representation of Tirana Riverside Project

Note. Data source: ("Tirana Riverside | Albania," n.d.)

5.4.1 Research relevance of the Tirana Riverside Project

The path to smart cities is full of challenges, especially for cities like Tirana that have undergone radical economic, social, and political changes over a long period of time. The challenges to having a smart city are certainly related to global ones in this regard, but there are also specific challenges faced by each country on their own. This occurs owing to various elements related to the distinctiveness each country embodies in historical, cultural, political, social, and economic contexts, as well as the vision they have developed for transformation and adaptation across generations. While digital transformation has brought about many advantages for the development of a smart city, it also presents a number of challenges that require careful attention through well-planned initiatives. History and studies have shown that countries that base their development on citizens have flourished in the policies and initiatives undertaken. The citizen is the main actor who is affected by any change or step taken in the country where they live; therefore, taking into account their opinion and their ideas encourages shared responsibility and active involvement.

Since Tirana has made great progress in the development of infrastructure and services, as well as in the improvement of urban spaces, greatest attention is paid to areas that are considered less regular and developed. In this context, interventions in this area, known as the “5 Maji” neighborhood, were considered reasonable. The maps in Figure 56 illustrate how the area appeared in 1999 and 2018, providing a basis for understanding the transformations that occurred before the project started in 2020. These visuals help distinguish the pre-project conditions from the post-project developments shown in the subsequent maps.

Figure 56. (a) 5 Maji zone in 1999 (b) 5 Maji zone in 2018

These two orthophotos are valuable for better understanding the morphological evolution of the area before the start of the project, where the densification of buildings (mainly informal) and the lack of a proper urban infrastructure are noted. Subsequently, several analytical maps were developed, which are divided into several phases, each of which represents a step in the transformation of the area, specifically: the situation before the project, the construction phase and the final planned phase of the project. The result is an approach that allows for a clearer spatial and temporal visualization of the transformation because the traces of the buildings and the implementation phases are superimposed on the satellite images provided by the existing maps.

Figure 57. Transformation of the 5 Maji redevelopment area in Tirana (2018-2025): (a) Area before demolition (2018); (b) Construction phase (2023); (c) Completed redevelopment works (2025)

Note. Data source: (Goci & Harris-Brandts, 2025)

Beyond this narrative of spatial transformation presented above, from the field visits, a contrast is noticed that this intervention generates in the existing area. The contrast is both visual, spatial, and functional because, as illustrated in the image below, the buildings have a different standard and are in a structured form, creating an unfinished landscape. This situation makes the project a significant case study for understanding urban development dynamics and the challenges of transitioning from an irregular structure to a planned urban model primarily driven by top-down decision-making.

Figure 58. 5 Maji neighborhood - 2025

Furthermore, at the current state of construction, a massive concreting of recreational spaces, leaving minimalist green spaces, can be noticed. This is illustrated by the following photos taken in the field during 2025.

Figure 59. Tirana Riverside Project greenery

According to news outlets, primarily from television media, this initiative has incited significant opposition among the local population. The Tirana Riverside Project has resulted in the production of numerous articles, news segments, shows, and books. Most of the material express dissatisfaction on the part of residents of that area, who are directly affected and have to vacate their homes and properties. Although the urban plan was approved by the relevant institutions and had a binding character according to the legislation in force, one of the most controversial elements was the fact that the local community was not consulted in a transparent and comprehensive manner before the approval of the intervention.

The mandatory nature of the plan, as stipulated by the legislation recognized by the relevant authorities, coupled with the lack of citizen consultation engendered a spirit of hostility towards the project proposed for their lands. The Local Mandatory Plan is a document prepared by the local government as a planning response that may include reconstruction after natural disasters or the rapid development of a territory for public needs. Such circumstances fostered a palpable environment of skepticism towards the institutions and opposition to the project overall, despite the stated objectives of enhancing quality of life and advancing the region.

This is precisely why this particular case was chosen for further study. Therefore, the lack of citizen involvement in the urban planning process of the area they are part of, according to the aforementioned transmissions, constitutes a case of interest in this research that is closely related to the concept of participation. This case study presents opportunities to comprehend the significant role of citizens in planning processes, the impact of their non-involvement, the associated consequences, and, crucially, how the interaction model between competent institutions and citizens in urban affairs can be enhanced.

5.4.2 Framework implementation for the Tirana Riverside Project

The previous chapter presented a summary of the methodological framework followed in this research, providing a clear overview of the main steps of the empirical work on the data and their processing in the Albanian language. In this section, these processes are treated in detail and illustrated through concrete examples, based on the case study of the Tirana Riverside Project. Initially, the structure of the questionnaires used to collect opinions from citizens and experts is presented, since all their fields are represented by ML as variables directly related to the structure of the dataset that is analyzed further. Next, the processes of labelling, lemmatization, and the comment processing system are discussed. The techniques used for data preprocessing represent a customized approach, developed specifically for languages with limited resources, such as Albanian. It is precisely this workflow and this methodological model that constitute one of the elements that make this research unique and of scientific importance.

5.4.2.1 Data sources and dataset description

As previously mentioned, data were collected through questionnaires disseminated via social media platforms. This process was done anonymously, with explicit information provided regarding data privacy and usage to encourage respondents to participate freely and without concern. The structure of the questionnaires designed for citizens and experts is as follows:

✓ **Citizen survey- Key themes and issues explored**

The questionnaire prepared for citizens is designed in several main parts:

1. Questions that aim to understand the citizen involvement in the project
2. Questions that aim to understand the citizens satisfaction with the aspects offered by the project in terms of infrastructure, environment, mobility, etc.
3. There are also questions that are designed to be studied on their own, such as social media usage, the willingness to be involved in project consultations or other community activities, and personal data such as age, place of residence, etc. These questions are detailed as follows.

Survey structure:

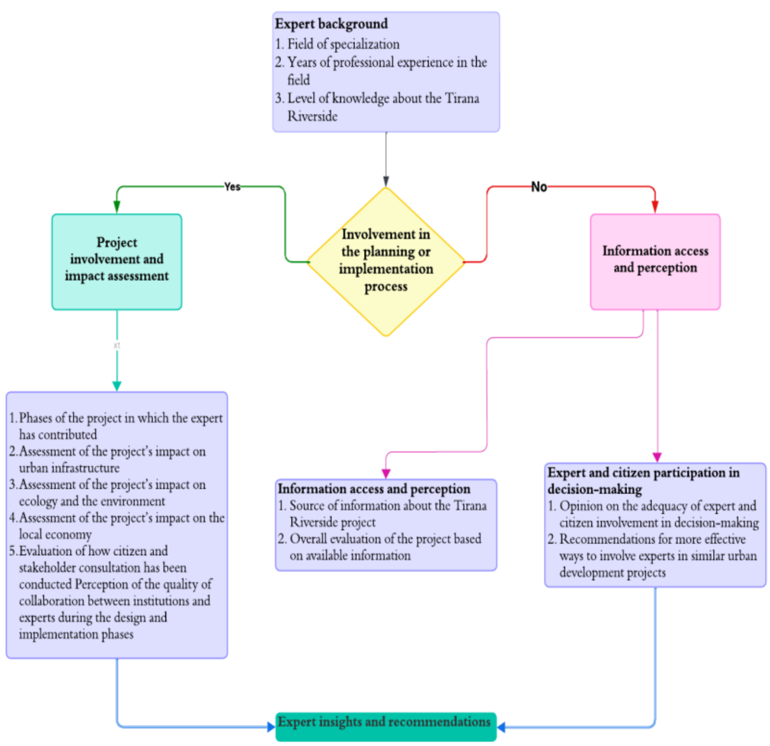
1. Personal data
    - Age
    - Duration of residence in the area
    - Residential zone
2. Participation (awareness and engagement)
    - Level of awareness regarding the project
    - Perception of inclusion in planning or decision-making
3. Project opinion
    - Opinion on the environmental focus of the project (e.g., green spaces, tree planting, sustainable buildings)
    - Opinion on the housing aspect (e.g., new apartments, architectural style)
    - Perceived feasibility of the “15-minute city” concept in the community
    - Feelings about proposed mobility solutions (e.g., bike lanes, pedestrian zones, electric vehicles)
    - Concerns regarding potential effects on traffic and access to local services

4. <u>Community engagement potential</u>
   - Willingness to participate in community activities and to attend project update meetings
5. <u>Survey dissemination</u>
   - Source through which the respondent accessed the survey (e.g., social media platform)
6. <u>Citizen feedback</u>
   - Open-ended comments regarding project improvements, community inclusion, and challenges to long-term success

✓ **Expert survey- Key themes and issues explored**

The expert questionnaire is constructed distinctly due to varying levels of expertise on the project and differing perceptions (Graphic 7).

Graphic 7. Experts' survey (key themes and issues explored)

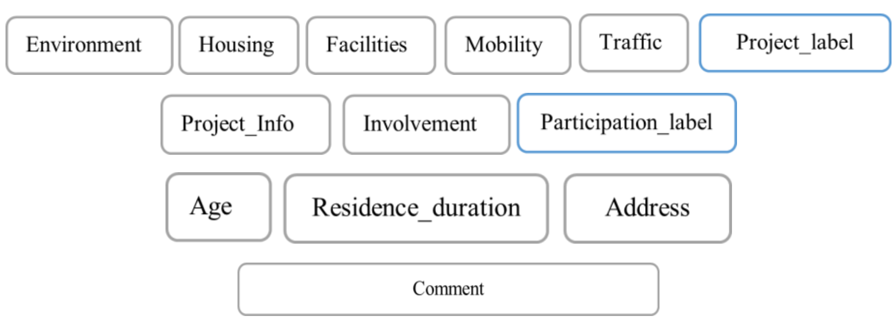


As illustrated in the diagram, the questions separate experts who have been involved in the project at any level from those who have not, even as consultants. If experts are not involved in the Tirana Riverside Project, various questions have been selected regarding the project's ecological, infrastructural, and economic assessment. Furthermore, experts are asked to give their opinion on the involvement of ordinary citizens and experts in this project and what would be the best ways to achieve inclusiveness. When experts have participated in the project, in addition to questions about its quality, importance is also given to the way it has been applied to maintain cooperation between citizens, experts, and relevant institutions.

- ✓ **Dataset structure**

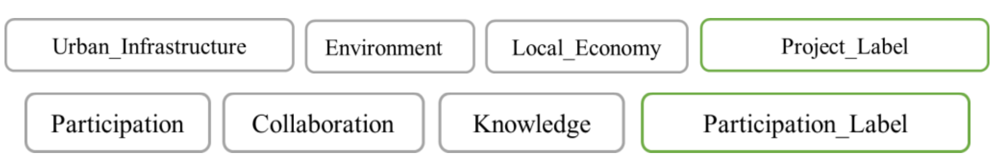
After collecting the responses, the dataset includes demographic data, evaluations of the project's dimensions, assessments of participation in the project, and free comments. The names of the fields are important because each part of data, represented by different columns in the dataset, is used in the following steps through illustrative examples to clarify the pipeline. Therefore, they are described through the following scheme. The first five fields/dimensions are directly related to the evaluation of the project; the next two fields are related to the perception of citizens about participation; and then follow the demographic fields, which are left out of the two categories since they were used further in the ML analysis. 'Project_label' and 'Participation_label' are crucially needed to enable further analysis using ML and AI techniques in subsequent stages. They are fields that receive value based on the ratings given by citizens in certain fields that are grouped based on the logic given in the Figure 60, that will be explained in the next section. To conclude the dataset structure, the comment field, which has a completely dedicated processing model that will be illustrated in the following sections, is initially not part of any category ('Project' or 'Participation').

Figure 60. Citizens' dataset structure



The logic of the dataset for ML analysis purposes works the same for data collected by experts. The following figure shows the fields taken into account in the study:

Figure 61. Experts' dataset structure



Specialization | Experience | Info_Source

Comment

It is understood that one of the objectives on distributing these questionnaires, was to obtain a maximum number of replies from locals impacted by the project to ensure the feedback was as authentic as possible, enabling the model to produce precise results. The total responses from citizens amounted to 300 (which went up to 520 records after final processing), while those from professionals ranged between 60 and 70. It is acknowledged that, in the case of specialists, the challenge in gathering replies was exacerbated by difficulties in contacting them, their dispersion across several institutions, and their restricted availability to engage in academic research questionnaires.

5.4.2.2 Data labeling for the ML methodology

Since the data analysis aims to understand the real sentiment of citizens about the changes made after the Tirana Riverside Project, the necessary ML technique is supervised learning. In this technique, each of the collected data records must be labelled, i.e., labelled as positive, neutral, or negative. In this study, this process is performed automatically through a function in JavaScript, which is a client-side language. Being client-side, this language is suitable for performing functionalities that do not need a central server to be managed or processed. As mentioned at the beginning in the description of the dataset, it is conceived in two main parts, can be illustrated schematically as follows:

Table 9. Conceptual illustration of data processing

Participation	Project	Comment	Participation_label	Project_label
XXX	XXX	A. B. C	L1	L2
		A	L1	
		B		L2
		C		L2

The domains concern citizen engagement in the project and those pertaining to the principal elements, including housing style, ecological considerations, and proposed mobility solutions, among others. The comment field is addressed in a distinctly specialized manner for this case study. Additionally, there are other fields not included in any of the sections depicted in the aforementioned image, which will be addressed independently in the final data analysis.

The fields that are part of 'Project' are labelled based on the following logic:

```
var label = (pos >= 3) ? 1 : (neg >= 3) ? 0 : (neu >= 3) ? 2 : (pos == 2 && neg == 2) ? 2 : (neu == 2 && pos == 2) ? 1 :
(neg == 2 && neu == 2) ? 0 : '';
```

where pos, neg and neu are variables that store the number of positive, negative and neutral responses. The labeling in this case is defined as follows:

- ✔ If there are three or more answers that belong to one category (pos, neg, neu) then the label will be the one assigned to the corresponding class. Specifically, positive responses are assigned a label of 1, negative responses are assigned a label of 0, and neutral responses are assigned a label of 2. For example, if there are three or more positive responses, the label is automatically assigned a 1.

Since the project evaluation aspect has taken into account five areas ('Environment', 'Housing', 'Facilities', 'Mobility', 'Traffic'), there are also the three following labelling options:

(pos == 2 && neg == 2) -> label=2, the case where two answers are positive and two are negative, the label is considered neutral.

(neu == 2 && pos == 2) -> label=1, the case where two responses are neutral and two are positive, the label is taken as positive.

(neg == 2 && neu == 2)-> label=0, the case where two answers are negative and two are neutral, the label is taken as negative.

The answers are marked as positive, negative, or neutral through a mapping function that determines, for each question, the positive, negative, or neutral answer. For example, let's take the case of the question related to the concept of mobility.

```
var map = { 'Si ndiheni ne lidhje me zgjidhjet e mobilitetit te propozuara (korsi per biçikleta, zona per kembesore,
automjete elektrike)? ': {
/** How do you feel about the proposed mobility solutions (bike lanes, pedestrian zones, electric vehicles)? */
    positive: ['Shume mbeshtetes'], /** Very supportive */
    negative: ['Kunder'], /**Against */
    neutral: ['Neutral'] /** Neutral */
  } };
```

Meanwhile, the following function makes it possible to count the answers given by the user immediately after the Submit button is pressed:

```
for (var question in map) {
  var qIndex = headers.indexOf(question);
  if (qIndex !== -1) {
    var r = row[qIndex];
    if (map[question].positive.includes(r)) pos++;
    else if (map[question].negative.includes(r)) neg++;
    else if (map[question].neutral.includes(r)) neu++;
  }
}
```

The fields belonging to 'Participation': 'Project_Info', 'Involvement' will be labelled separately, with the following logic:

```
var informim = row[headers.indexOf('Sa te informuar ndiheni ne lidhje me detajet e projektit?')];
/** 'How informed do you feel about the details of the project?' */
var pjesemarrje = row[headers.indexOf('A ndiheni te perfshire ne kete projekt?')];
/** 'Do you feel involved in this project? */
var label1 = (informim === 'Shume te informuar' && pjesemarrje === 'Po') ? 1 : 0;
sheet.getRange(rowIndex, label1Col + 1).setValue(label1);
```

If the answers are 'Very Informed' for the question 'How informed do you feel about the details of the project?' and 'Yes' for 'Do you feel involved in this project?', the label is taken as 1 (positive) and 0 (negative) in the opposite. This case is simpler than the first one since it contains only two questions. The column names are the same as the questions in Google Forms, so they're in Albanian. During data processing, the names have been translated into English for the reader's convenience. These created functions, which are essentially sets of instructions, are invoked within the main script function in Apps Script, namely onFormSubmit(). This function plays an essential role, being automatically activated whenever a new response is recorded in Google Sheets. In the automatic execution of various functions within the code, triggers come into play, which is a mechanism that allows the execution of functions based on certain events. For example, when a window is opened, a function is executed; when a certain time passes, another one is executed, etc. The trigger can be defined manually or with a code. In the case of the basic script function, onFormSubmit(), it is integrated into it. After the data is downloaded in .csv format and the columns are renamed, it will be entered into the ML phases for statistical analysis and final model generation. The processing of the comment field plays a very important role in this study, and there is a completely customized system for how they are handled. The process of labelling them is somewhat complex, so it will be explained further in a separate section.

5.4.2.3 Lemmatization and the creation of a minimal vocabulary in the Albanian language

Lemmatization is a very necessary ML process to have clear data to work on further analysis and more in-depth processing. The accuracy of the final model largely depends on how well the data is structured. Data is considered ‘clean’ if it does not contain irrelevant words, such as nodes, and if the remaining words appear in their main meaning after removing any prefixes and suffixes. Extracting words in their root meaning significantly enhances the analysis conducted in later steps using algorithms chosen based on the study's objective and the nature of the collected data. Several NLP libraries, including NLTK, spaCy, Stanza, TextBlob, etc., enable this process in ML. But these libraries support several important languages, such as English, Italian, French, etc., and not the Albanian language. Therefore, this work phase, in this study, will be carried out partly manually and partly automated through several scripts as below.

Initially a file with stopwords is created. Stopwords are words that have no value in data analysis and are therefore excluded from the rest of the data when they are processed. This phase was conducted by creating a collection of Albanian language keywords, compiled from various literary sources, to ensure they can be easily identified. Unlike other languages such as English, no comprehensive resource currently exists that consolidates them in a single source. For example, some stopwords are ‘te’, ‘edhe’, ‘vec’, ‘cdo’, ‘sa’, ‘vec’, etc. In English, these words correspond to ‘also’, ‘each’, ‘all’, and ‘how’, while for the keywords ‘te’ and ‘vec’, there is no corresponding word in English. This has to do with the fact that each language has its uniqueness in terms of grammar, lexicon, semantics, etc. In this context, translating Albanian into English using different software tools may not fully capture the nuances of words and their intended meanings. To solve this problem, it is necessary to create a corpus that contains all the words of the Albanian language with all their forms. The 1980 Albanian dictionary contains about 41,000 words, while the 2006 Albanian orthographic dictionary contains about 58,000 lexical units. When performing lemmatization, the rich morphological structure and complexity that characterize this ancient language must be taken into account. This requires that the library that will carry out this process be able to distinguish the different morphological, semantic and syntactic forms of each word in order to extract their roots.

So, lemmatization is a complex process that must first recognize:

- The grammar of a language includes several components: number (singular and plural), case (which can take seven forms such as nominative, genitive, dative, accusative, etc.), form, gender, the influence of final vowels etc.
- Depending on the function that each word has in the sentence, other properties must also be taken into account, such as in the case of verbs: verb tense (present, future, past, perfect, etc.), mood (imperative, subjunctive, etc.), active or passive form, etc.
- There are also words with a more special role, such as adverbs and pronouns that have completely different properties from other words. The steps followed for lemmatization in the created script are:

A Set() is created to store the words in this instruction:

```
const fjaleUnike=new Set();
```

Then, for each row of the dataset, the removal of punctuation marks, blank spaces, and stop words is applied, as follows:

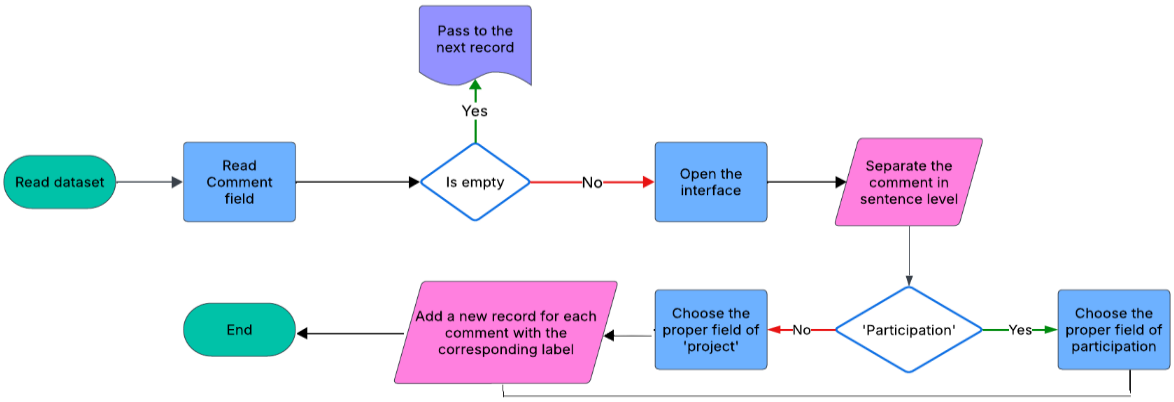
```
rows.forEach(row => {
  row.forEach((cell, colIndex) => {
    if (!excludedColumns.includes(colIndex) && typeof cell === 'string') {
      const fjale = cell
        .toLowerCase()
        .replace(/[^\p{L}\p{N}\s]/gu, '')
        .split(/\s+/)
        .filter(word => word && !stopwords.has(word));
        fjale.forEach(f => fjaleUnike.add(f));
    }});
```

After this functionality is applied, a new file is generated with the words contained in the dataset, and the process of matching the root for each word is done manually. The final file created is necessary to continue with the further steps of data preprocessing.

5.4.2.4 System for comment processing

The most important part of the constructed questionnaires is the comment field, where citizens and experts have the opportunity to express their opinions without a fixed framework such as multiple-choice questions. Therefore, a custom system has been built for their processing, as shown in the diagram below.

Graphic 8. Comment preprocessing flowchart

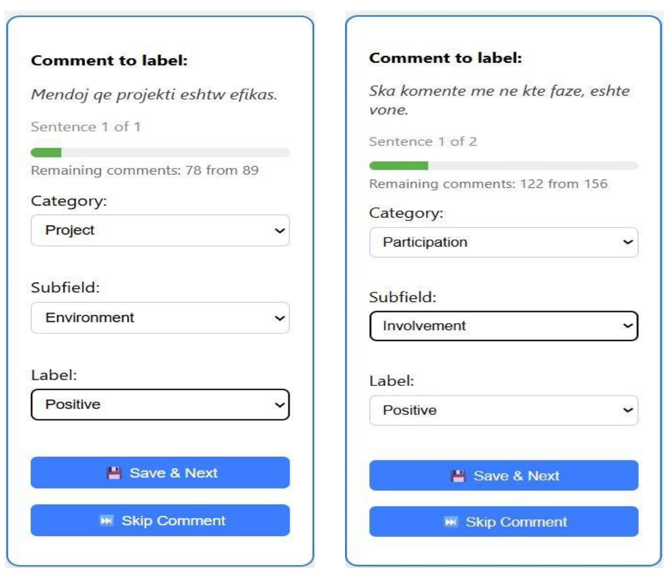


Reading the comment field. It will be read into the dataset as long as there are comments (this field can also be empty because it's a non-mandatory one to fill in). If the comment is not empty, it is read and split at the sentence level using the given logic:

```
const sentences = comment.match(/[^.!?]+[.!?]*/g) || [comment];
```

This division is important for the study because it provides a detailed analysis and promotes the development of a more efficient model by the end of the data analysis. For each sentence of the comment, an assessment is made for the category to which it belongs. This assessment is presented in Figure 62 using interfaces developed specifically for this purpose.

Figure 62. Comment labeling interface



If the comment is within the scope of the project, then the logic continues by filling in the field it belongs to. Let's take an example. Suppose the comment is like this: “I'm not aware of what's going on here!”. Then:

The comment belongs to ‘Participation’ between the two areas that belong to this concept (‘Project_Info’, ‘Involvement’) is related to information related to the project. Consequently, the comment will be labelled as negative (with a value of 0), and a new record will be added to the dataset. The new record contains general data such as the ID and the comment, which in this record will be represented by the fixed value of the field to which it belonged. The technique used in this case is illustrated in Table 10.

Table 10. Illustrative case of the applied technique

Participation		**Project**					**Comment**	**Participation_label**	**Project_label**
F1	**F2**	**F1**	**F2**	**F3**	**F4**	**F5**			
..	..	..	..	..	..	..	Comment_A	L1	L2
Not informed at all								L1=0	

In this example, we mark the comment “I don't know what’s going on here!” as ‘Comment_A’ and evaluate it. In the field directly related to the comment, ‘Project_Info’ (F1 in the figure), it is evaluated what the possible answers to this question are:

a. Very informed
b. Not very informed
c. Not informed at all

The alternative that suits me is ‘Not informed at all’, so in the ‘Project_Info’ field, this alternative is written. The label is set to ‘Participation_label’, while the label for the ‘Project’ fields remains blank. To implement these functionalities, a link has been defined between the answer alternatives for each question with the corresponding labels as follows:

```
const subfieldAnswerMap = {
  "Çfare mendoni per aspektin e strehimit te projektit (apartamente te reja, stili arkitektonik)?": {
   /* "What do you think about the housing aspect of the project (new apartments, architectural style)?"*/
    "0": "Ka nevoje per ndryshime", /*  There is a need for changes*/
    "1": "I pershtatshem", /* "Appropriate" */
    "2": "Mesatar, mund te permiresohet" /* "Average, could be improved"*/
```

```
},…….
```

This mechanism enables the translation of the selected label into the appropriate text that corresponds to the response of the selected field. The next step is to add the completed data to the interface as a new row, which specifically stores the original row ID, the written comment, the selected label, and, within the designated field, the corresponding value associated with the label (through the *subfieldAnswerMap* object).

```
let newRow = Array(headers.length).fill("");
      newRow[0] = id;
      newRow[commentIndex] = comment;
      if (labelIndex !== -1) newRow[labelIndex] = labelValue;
      if (subfieldIndex !== -1 && answerText) newRow[subfieldIndex] = answerText;
```

In the processing for the participation study, all rows labelled with 'Participation_label' are included, while the remaining rows are used for the project study. As previously mentioned the dataset after final processing contains about **520** records. While maintaining a minimal vocabulary of words for the process in the Albanian language, this methodology achieves the objective of considering the comments of citizens/experts.

5.4.3 Text representation and vectorization for ML models

To achieve the purpose of the study, the analysis of the collected information discussed above is carried out. This goal is addressed by the problems of ML and DL classification. Several algorithms have been applied in this phase of the work. Each of the selected algorithms has its own characteristics for use, and this allows data analysis to be carried out in different ways, which is also necessary for the reliability of the results.

It is very important to evaluate the performance of the model generated after applying these algorithms with different parameters and conditions. Of course, there have been algorithms that have not performed at the appropriate level for factors that are briefly explained below. But the process of testing them adds value to the work because it helps to understand which algorithms are most suitable for use in certain conditions. The information used in this study is text-based, and the classification algorithms used operate by converting textual data into numerical representations, a process commonly referred to as vectorization.

Vectorization and TF-IDF method

Vectorizing data means converting it from text to numeric format, making it readable by ML and DL algorithms. The literature suggests specific vectorization methods that are better suited for different algorithms. Table 11 presents a summary of these methods used for each classification algorithm used in this study.

Table 11. Applied vectorization methods

Algorithm	Vectorization method
Multinomial Naïve Bayes	TF-IDF
Logistic Regression	TF-IDF
Support Vector Machine and Random Forest	TF-IDF
Convolutional Neural Network	Embedding
Multilayer Perceptron	TF-IDF

The TF-IDF method focuses on the importance (weight) of each word in the text it is part of and in the entire dataset. Specifically, this method is implemented with the code below:

```
Tfidf_vect = TfidfVectorizer(
    max_features=3000,
    ngram_range=(1, 2),
    min_df=2,
    max_df=0.85
)
```

Let's interpret these instructions since they have a fundamental importance in the logic used for data processing. The TfidfVectorizer method converts text into a numeric vector, where each word is represented by a weight using the parameters as follows:

- max_features=3000 defines the maximum number of features that the model can process, avoiding the phenomenon of overfitting and limiting the complexity of the model. Based on the weight calculated by the corresponding TF-IDF formulas, the words (ngrams) that have the most value within the corpus are selected.
- ngram_range = (1, 2) is used to capture words or phrases that make more sense together. For example, in the case of the input text ‘the road is damaged’, the corresponding unigram would be a vector like this [‘the’, ‘road’, ‘is’, ‘damaged’], while in the bigram the vector would look like this [‘The road’, ‘road is’, ‘is damaged’]. This form of interpretation helps the model capture the context of words more easily.

- min_df = 2 is a parameter that removes words from the corpus that are repeated only once, as they are statistically meaningless and unnecessarily increase the model's complexity.
- max_df = 0.85 is the opposite of min_df. It removes from the corpus words that are repeated many times because they hinder the classification of classes. In this case, those words that occur in over 85% of the documents (sentences) are removed.

For example, the following words that are part of the dictionary, and associated with the indexes 0,1,2:

```
{
 'banesa': 0, /*housing*/
 'jo i pershtatshem: 1, /*not appropriate*/
 'hapesire': 2 /*space*/
 ...},
```

are vectorized by the TfidfVectorizer method and the vector calculated for an input (record in the corpus) is like this: [0.0, 0.0, 0.0, 0.583, 0.0, ..., 0.0], then the TF-IDF value of the word ‘'space" which in the dictionary corresponds to index 2, is 0.0, i.e. the second value in the vector. The instruction that makes these functionalities possible is:

```
Tfidf_vect.fit(Corpus_clean['text_final'].apply(lambda x: ' '.join(x)))
```

While the Tfidf_vect.fit() function distinguishes words by considering the corresponding dictionary of words and calculates IDF values. These are the steps that are followed to make the data readable for the model.

TD-IDF is the vectorization method used in all algorithms except the CNN algorithm where another logic is used which will be discussed below.

5.4.4 Algorithmic approaches and models

After converting the data into a readable format for the model using the TF-IDF vectorization method, the next step consists of applying algorithms to build the final models. Several classification algorithms were tested in this phase, and in addition, various mechanisms were applied to improve the model's performance, such as data balancing using the Synthetic Minority Oversampling Technique (SMOTE), parameter optimization, etc. In the end, the performance of generated models was evaluated using various metrics, including accuracy, F1 score, recall, precision etc. The following outlines the steps taken to implement these algorithms, ensuring efficient models for both citizen and expert perceptions.

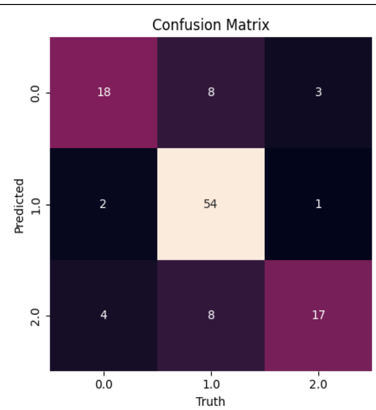
5.4.4.1 Application of ML models to citizens' perception analysis

For the dataset containing the opinions expressed by citizens about the project, some of the most important classification algorithms from ML and DL have been tested. These algorithms and techniques applied are explained in the subsequent sections.

Multinomial Naïve Bayes (MNB)

MNB is an algorithm that belongs to supervised learning and is based on a 'naïve' assumption: that the data (features) are independent of each other. It is an assumption that is not true because data is usually complex and fields are interconnected. But as a probabilistic model, it usually gives very good results. The model has a 77.4% accuracy for the 'Tirana Riverside Project' dataset, which only considered project-related fields. Furthermore, the confusion matrix in Table 12 indicates that the model struggles with class distinction.

Table 12. MNB algorithm (confusion matrix and classification report)



	precision	recall	f1score	support
class 0	0.75	0.62	0.68	29
class 1	0.77	0.95	0.85	57
class 2	0.81	0.59	0.68	29
accuracy			0.77	115
macro_avg	0.78	0.72	0.74	115
weighted_avg	0.78	0.77	0.76	115
ACCURACY: 0.7739130434782608				

To solve this problem, several methods were used, one of which was to modify the TF-IDF parameters as follows:

```
TfidfVectorizer(
    max_features=3000,
    ngram_range=(1, 2),
    min_df=2,
```

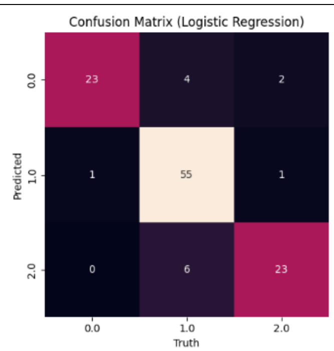
```
    max_df=0.85
)
```

However, the model's performance did not change significantly, indicating that this algorithm, although very fast and often efficient, is not suitable for application to data that has high semantic similarity.

Logistic Regression (LR)

The LR algorithm is highly suitable for data classification, and when applied to the dataset from the Tirana Riverside Project, it produced very efficient results. The algorithm calculates the probability that a given data item belongs to a certain class, and in our case the model made these predictions with an overall accuracy of 87.8%. The following table shows the confusion matrix and the evaluation metrics for each of the classes. From the confusion matrix, it is noted that opinions in favor of the project were correctly classified in 97% of cases, and those against were correctly classified in 79% of cases. On the other hand, as shown in Table 13, neutral responses since they showed linguistic similarities with positive responses, were more challenging to classify.

Table 13. LR algorithm (confusion matrix and classification report)



	precision	recall	f1score	support
class 0	0.96	0.79	0.87	29
class 1	0.85	0.96	0.9	57
class 2	0.88	0.79	0.84	29
accuracy			0.88	115
macro_avg	0.9	0.85	0.87	115
weighted_avg	0.88	0.88	0.88	115
ACCURACY: 0.8782608695652174				

The data has been transformed into numerical data using the TF-IDF mechanism, and also within this function, unigrams and bigrams are included. These ideas involve capturing phrases to interpret words that have more meaning together. This applies specifically to expressions or phrases.

```
ngram_range=(1, 2)
```

The above results show that the model generated by the LR algorithm can extract citizen attitudes with an accuracy of 87.8%, which makes this model valuable for analyzing public opinion about various urban projects or issues.

But accuracy alone is not enough to fully assess the model's performance. This is because the confusion matrix shows that negative and neutral responses are sometimes confused with each other. Accurately classifying each expressed opinion is crucial for ensuring the analysis is valid and considers even the rarer opinions, especially since the majority of opinions in this case are positive. To avoid this phenomenon known as oversampling, the following method is applied:

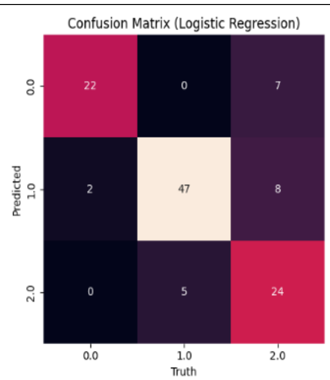
```
model = LogisticRegression(max_iter=1000, class_weight='balanced')

model.fit(Train_X_Tfidf, Train_Y)

predictions = model.predict(Test_X_Tfidf)
```

The class_weight='balanced' option is used in this case to ensure that even the less represented classes in the data are accurately identified by the final model. This technique makes the model more precise and sensitive to negative and neutral opinions, which are fewer in this case. But after applying class weight balancing, the metrics change (see Table 14), leading to a change in the accuracy of the model from 87.8% to 81%.

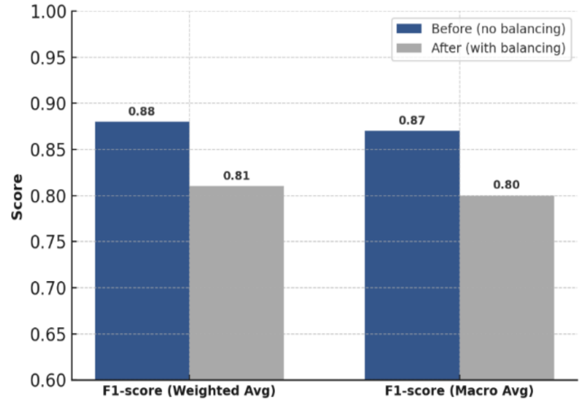
Table 14. LR algorithm (confusion matrix and classification report)



	precision	recall	f1score	support
class 0	0.92	0.76	0.83	29
class 1	0.9	0.82	0.86	57
class 2	0.62	0.83	0.71	29
accuracy			0.88	115
macro_avg	0.81	0.80	0.80	115
weighted_avg	0.83	0.81	0.81	115
ACCURACY: 0.808695652173913				

This mechanism, while efficient in many cases and widely used in the LR algorithm, did not improve the model in this particular case. The classification report and the graph below show a decrease in precision, F1-score, and other metrics.

Graphic 9. Model comparison before and after class balancing



The sensitivity to the neutral class (class 2) was increased but negatively affected the analysis of other classes. Balancing the classes should be done with techniques that do not reduce the overall performance of the model. For this, the SMOTE technique was applied, thresholds were set, GridSearchCV was used, etc. These steps are explained as follows:

<u>Phase 1</u>. SMOTE

SMOTE is an ML technique used in cases where the data is unbalanced. The logic of this technique is based on creating new examples in the data, choosing two closest points in the less represented classes. New examples are created in their vector space and help the model learn the features of the minority classes. The code that makes this application possible is as follows:

```
pca = PCA(n_components=2)

Train_X_2D = pca.fit_transform(Train_X_Tfidf.toarray())

X_resampled_2D = pca.fit_transform(X_resampled.toarray())
```

Principal Component Analysis (PCA) is an ML mechanism used to reduce the dimensions of a dataset while preserving as much information as possible.

This mechanism is necessary to reduce the complexity of the data to generate more performant models. Since the TF-IDF vectorization method represents each opinion (record) in the dataset as a multidimensional vector, PCA calculates the lines (vectors) with the highest variance. In this way, each opinion is projected using two values, PCA1 and PCA2. The construction of graphs before and after SMOTE is done by the following functions. Before SMOTE, the data is taken from the training set Train_Y, while afterwards it is taken from y_resampled, which is now modified, including synthetic instances.

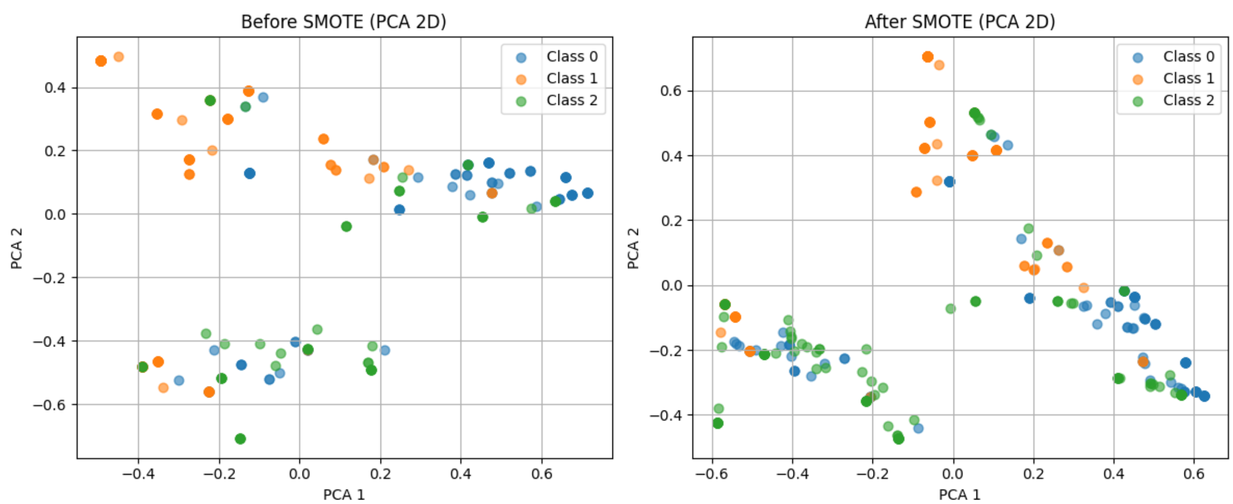
```
plt.figure(figsize=(12, 5))
plt.subplot(1, 2, 1)
for cls in np.unique(Train_Y):
    mask = (Train_Y == cls)
    plt.scatter(Train_X_2D[mask, 0], Train_X_2D[mask, 1],
            label=f"Class {cls}", alpha=0.6, s=40)
```

```
plt.subplot(1, 2, 2)
for cls in np.unique(y_resampled):
    mask = (y_resampled == cls)
    plt.scatter(X_resampled_2D[mask,0],
X_resampled_2D[mask, 1],
            label=f"Class {cls}", alpha=0.6, s=40)
```

The graph below shows the change that has occurred in the classes' distributions. Each point in the graph represents an opinion (a record in the dataset), and the color represents the classes that belong to 'Project_label', specifically:

Class 0 -negative answers, Class 1-positive answers and Class 2- neutral answers.

Graphic 10. Class distribution before and after SMOTE



Phase 2. This step involves the manual determination of the weight of each class. In this step, the weight is manually assigned to each class in this way:

class_weights = { 0: 1.2, 1: 0.95, 2: 1.15 }

Thus, class 0 is given 12% more weight, class 1 is reduced in importance since it is the dominant class, and class 2 (neutral) is assigned 15% more weight. This technique helps the model to take minority classes into account as well.

Phase 3. Applying different thresholds for each class.

Thresholds define the minimum level of accuracy needed to classify a class. For example, in this case the thresholds are defined as follows:

```
thresholds = { 0: 0.58, 1: 0.48, 2: 0.55}
```

Specifically, with this definition, the model cannot classify classes if the accuracy is not above 58% for class 0, above 48% for class 1, and above 55% for class 2. This way it is more certain that the model will perform properly in classifying classes.

Phase 4. Finding optimal parameters through GridSearchCV. GridSearchCV is used to automatically select optimal parameters. The parameters determine how the model learns from the data. In this case, the given values for the model are selected.

```
parameters = {‘C’: [0.3, 0.7, 1], ‘penalty’: [‘l2’], ‘solver’: [‘lbfgs’]}
```

Where C represents the complexity of the model. A low value avoids over-learning on the data, while a high value gives the model too much flexibility. Maintaining the stability of the model is achieved through the ‘penalty’ variable, while the ‘solver’ determines the optimization algorithm.

Phase 5. Performance evaluation

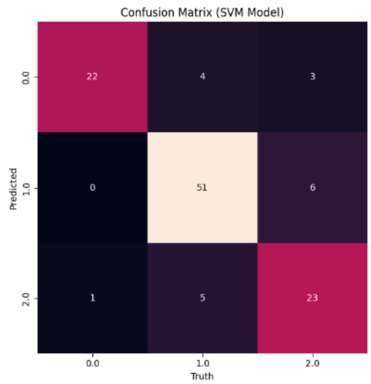
Performance evaluation is done through test data that is initially divided into datasets before applying any of the aforementioned balancing techniques.

In this case, it is noted that the results obtained are identical to the first case, before applying the aforementioned class balancing techniques. The use of advanced techniques such as SMOTE, GridSearchCV, etc., did not bring any noticeable improvement to the model; therefore, it is concluded that the final model for this algorithm is the one with 87.8% accuracy. A more optimal solution in this situation would be to use other vectorization methods, such as FastText, but the lack of large corpora trained for the Albanian language makes their use invalid. Because those methods are based on the semantic meaning of the word, which is not supported for the Albanian language yet.

Support Vector Machine (SVM) and Random Forest (RF) (ensemble average)

The next algorithm is SVM, suitable for datasets of this size and capable of identifying non-linear relationships in the data. Its application to the dataset yielded the following results:

Table 15. SVM algorithm (confusion matrix and classification report)



	precision	recall	f1score	support
class 0	0.96	0.76	0.85	29
class 1	0.85	0.89	0.87	57
class 2	0.72	0.79	0.75	29
accuracy			0.83	115
macro_avg	0.84	0.82	0.82	115
weighted_avg	0.84	0.83	0.84	115
ACCURACY: 0. 8347826086956522				

It is noted that the accuracy is 83.4%, a moderately satisfactory accuracy for a model, but the recall is low for the less represented classes, such as class 0 (negative) and class 2 (positive). In this case, too, the SMOTE technique has been used in advance for balancing. The model is trained using the SVM algorithm according to the provided instructions:

```
svm_model = SVC(kernel='linear', C=1, probability=True, class_weight='balanced', random_state=42)

svm_model.fit(X_resampled, y_resampled)
```

where X_resampled represents the new training data set after applying SMOTE, while y_resampled are the labels for them. To improve classification reliability, separate thresholds for each class have been applied:

```
proba = svm_model.predict_proba(Test_X_Tfidf)
adjusted_predictions = np.zeros(len(Test_Y), dtype=int)
thresholds = {0: 0.58, 1: 0.48, 2: 0.55}
……
```

To achieve higher performance, several new methodologies have been tried, such as:

Phase 1. Increasing max_features allows for more words to be considered, specifically n-grams such as unigrams, bigrams, and trigrams. Additionally, the method for calculating the Term Frequency (TF) value for corpus words is changing from a linear approach—counting how often each word appears in the document—to a logarithmic function, which is calculated as follows:

$TF = 1 + \log(tf)$ (XIV)

where tf is the frequency of occurrence of the term in the document. This calculation method reduces the weight of the most frequent words, allowing more important words that may be rarer to have a higher impact than before.

```
vect = TfidfVectorizer(
   max_features=5000, ngram_range=(1, 3), min_df=2, max_df=0.85,

   stop_words=nyjet['stopword'].tolist(), sublinear_tf=True)
```

Phase 2. Selecting the most appropriate features through the function:

```
('select', SelectKBest(chi2, k='all'))
```

Phase 3. Hyperparameter optimization using GridSearchCV by testing different combinations of parameters.

```
grid = GridSearchCV(pipeline, params, scoring='f1_macro', cv=5, verbose=1, n_jobs=-1)
```

Phase 4. Optimization of thresholds for classes and balanced calculation of class weights through the function:

```
weights = compute_class_weight('balanced', classes=np.unique(y_res), y=y_res)

weight_dict = {cls: w for cls, w in zip(np.unique(y_res), weights)}
```

Phase 5. The main step consists in combining the SVM algorithm with RF. RF is a very useful algorithm for classification tasks and has the advantage of good generalization. Therefore, it was chosen to be applied together with SVM. Combining the two algorithms together in ML is called ensemble averaging. This technique aims to take advantage of the strengths of each of the models in the generation, making the classification accurate and the model very efficient. The code that makes this method possible is as follows:

```
rf = RandomForestClassifier(n_estimators=200, class_weight='balanced', random_state=42)
rf.fit(X_res, y_res)
rf_proba = rf.predict_proba(Test_X_Tfidf)
combined = (proba + rf_proba) / 2
final_preds = np.argmax(combined, axis=1)
```

The two relevant confusion matrixes and classification reports are illustrated below:

Table 16. SVM and SVM+RF confusion matrixes

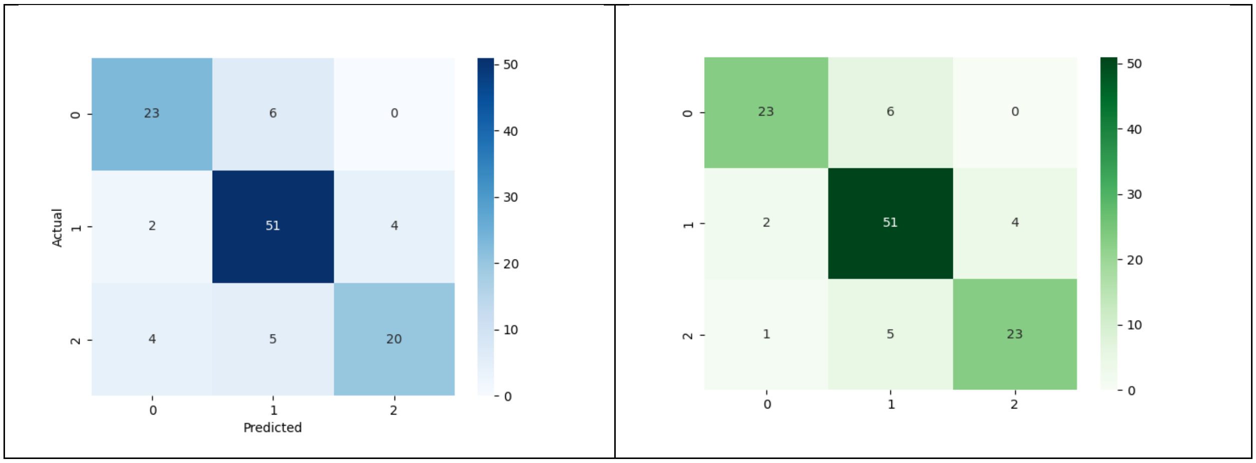


Table 17. SVM and SVM+RF classification reports

	SVM				Ensemble (SVM+RF)			
	precision	recall	f1-score	support	precision	recall	f1-score	support
class 0	0.79	0.79	0.79	29	**0.88**	0.79	**0.84**	29
class 1	0.82	0.89	0.86	57	0.82	0.89	0.86	57
class 2	0.83	0.69	0.75	29	**0.85**	**0.79**	**0.82**	29
accuracy			0.82	115			**0.84**	115
macro avg	0.82	0.79	0.80	115	**0.85**	**0.83**	**0.84**	115
weighted avg	0.82	0.82	0.82	115	**0.85**	**0.84**	**0.84**	115
Accuracy	0.8173913043478261				0.8434782608695653			

Considering that the accuracy increases from 81.7% to 84.3%, the model that combines SVM and RF is better and more stable. Most of the parameters have been improved, and this makes the second model perform better by identifying more accurately the neutral class (class 2), which was a problem in the other models. The final model is also the one with the ensemble technique, which has a better balance between classes and higher sensitivity to minority classes.

Convolutional Neural Network (CNN)

CNN as an algorithm belonging to DL works with neural networks. It is an suitable algorithm for sequential data and also for NLP tasks, especially when the goal is to analyze word patterns rather than their semantic meaning. The model for the CNN algorithm is built after filtering the corpus, applying minimum cases per class, converting the word list into a single text, splitting it into testing and training data, encoding, tokenization, and applying SMOTE for class balancing.

```
model = Sequential()

model.add(Embedding(input_dim=max_words, output_dim=128, input_length=max_len))

model.add(Conv1D(filters=128, kernel_size=5, activation='relu'))

model.add(GlobalMaxPooling1D())

model.add(Dense(128, activation='relu'))

model.add(Dropout(0.5))

model.add(Dense(num_classes, activation='softmax'))
```

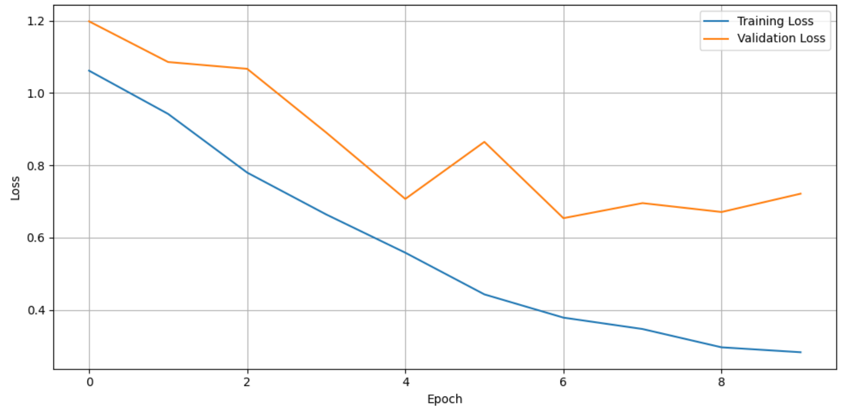
In this case, the TF-IDF method was not used for vectorization; instead, embedding was employed, which represents words in a vector form with a dimension of 128, and this representation is learnt during the training phase. It is a dynamic method, unlike TF-IDF, which calculates the frequency of occurrence of the word in the document in relation to its occurrence in the entire corpus. Further, through the Conv1D function, a one-dimensional layer is added to the model, which applies 128 filters, and the kernel size is 5. The kernel size determines how many words the filter will read in one pass. The 'relu' function aids the model in identifying even complex relationships within the data. GlobalMaxPooling1D() serves to simplify the model, generating a vector of 128 values for the data (based on the number of filters). Next comes the final block of instructions with two corresponding layers named 'fully connected layer' and the 'softmax layer'. The first one avoids the concept of overfitting, and the second normalizes the final result using the probabilities for each class.

A completely new technique used for this algorithm involves training with the EarlyStopping method. It is an efficient mechanism used to prevent the concept of overfitting where the model manages to learn very well on the training data (including unnecessary data) and has difficulty generalizing to new, unknown situations. This technique is usually used in algorithms whose training phase is a gradual, iterative process, such as CNN, XGBoost, etc., but not MNB, LR, etc.

```
early_stop=EarlyStopping(monitor='val_loss',patience=3,restore_best_weights=True)
```

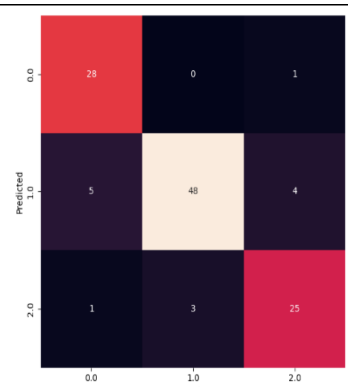
This function stops training if the loss in the data used to evaluate the model's performance during the training phase (validation set) does not improve for more than three iterations. Graph below illustrates the change in these parameters during training.

Graphic 11. Training and validation loss of CNN algorithm



Applying this function increases the reliability of the model, and by using the extra argument (restore_best_weights), the optimal model weights are saved, which are added to the model at the end of the training phase. The results obtained from the algorithm are illustrated in Table 18.

Table 18. CNN algorithm (confusion matrix and classification report)



	precision	recall	f1score	support
class 0	0.82	0.97	0.89	29
class 1	0.94	0.84	0.89	57
class 2	0.83	0.86	0.85	29
accuracy			0.88	115
macro_avg	0.87	0.89	0.88	115
weighted_avg	0.88	0.88	0.88	115
ACCURACY: 0.8782608695652175				

The classification results show a good balance between the classes, as indicated by the values of the metrics: precision, recall, and F1-score for each class. This asserts that the model is capable of efficiently identifying all data categories, and since the accuracy of the model is high (87.8%), it shows that the model can perform very well with new unknown data.

Multilayer Perceptron (MLP)

To further improve the model, the MLP algorithm has also been applied in combination with the TF-IDF method. MLP, as a sophisticated DL algorithm, consists of a series of neural layers. The first difference between this technique and CNN is the use of TF-IDF for vectorization rather than the commonly used embedding. Second, in the new model the structure is linear, and three Dense layers are applied to avoid overfitting, as in the given code:

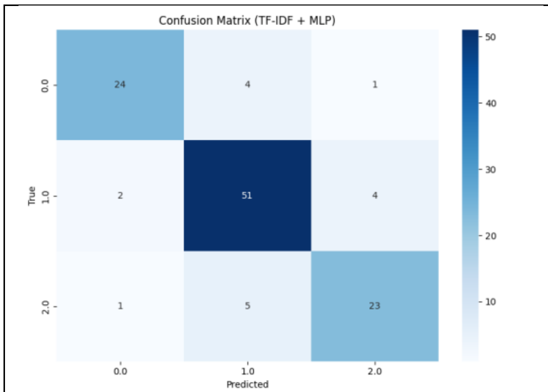
```
model = Sequential()
model.add(Dense(512, activation='relu', input_shape=(Train_X_tfidf.shape[1],)))
model.add(Dropout(0.4))
model.add(Dense(256, activation='relu'))
model.add(Dropout(0.3))
model.add(Dense(num_classes, activation='softmax'))
```

Furthermore, to protect overall performance, automated calculation of class weights has been performed using the following method, which in many cases is more efficient than SMOTE.

```
 weights = class_weight.compute_class_weight(...)
class_weights = {i: w for i, w in enumerate(weights)}
```

The EarlyStopping technique has been applied with the variable 'patience=5', and classes with less than three examples have been removed. In conclusion, this code presents the data in a more interpretive manner, and the results are:

Table 19. MLP algorithm (confusion matrix and classification report)



	precision	recall	f1score	support
class 0	0.89	0.83	0.86	29
class 1	0.85	0.89	0.87	57
class 2	0.82	0.79	0.81	29
accuracy			0.85	115
macro_avg	0.85	0.84	0.85	115
weighted_avg	0.85	0.85	0.85	115
ACCURACY: 0.8521739130434783				

It is noted that the model has a good performance, with a value of 85.2%. The metrics show that the model is able to provide balanced results across all classes. Additionally, the steps taken to apply this algorithm demonstrate that it is simpler to implement than the CNN algorithm discussed in the previous section, as it does not involve the complexities of convolutional layers.

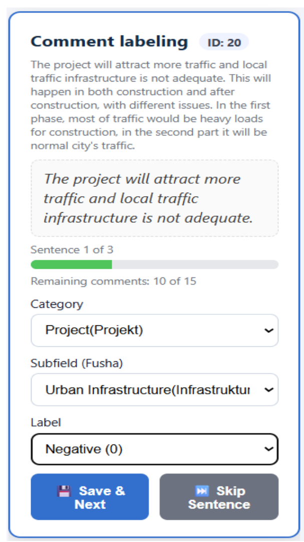
5.4.4.2 Application of ML models to experts' perceptions

The methodology specifies that the same approach used for analyzing citizens' opinions was also applied to the experts. To answer the questions as accurately as possible,

- Do these opinions present the truth?
- How close are these opinions with the reality?

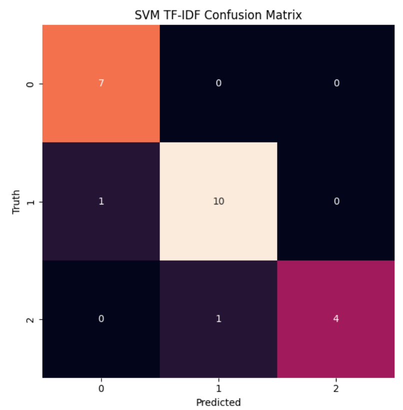
it is necessary to also take into account the views of experts regarding the Tirana Riverside Project. The two aspects studied are the same: project evaluation and public and expert involvement. The questionnaire was structured as given in Graphic 7 in the methodology section. All further steps, such as labelling, lemmatization and processing of comments, followed the same logic. Figure 63 illustrates the interface used to process comments made by experts in the field, left free for them.

Figure 63. Comments processing interface (experts' case)



After the preprocessing phase using JavaScript code is complete, the data processing continues with Python and ML. To generate accurate and efficient models on the data, a series of algorithms have been tested, including CNN. The result obtained by CNN was not optimal, with an accuracy that varies greatly in each execution from 52% to 91%. It is normal for CNN to have differences in accuracy in different executions due to the way it works, but not to such large values. This variation may come from the limited data for testing as a result of insufficient data. In total, there are about 90 records in the dataset, and the algorithm in question is not suitable for datasets of such a size. Therefore, the SVM algorithm with the TF-IDF method for vectorization was also used. The result obtained is illustrated in Table 20:

Table 20. SVM algorithm (confusion matrix and classification report)



	precision	recall	f1score	support
class 0	0.88	1.00	0.93	7
class 1	0.91	0.91	0.91	11
class 2	1.00	0.80	0.89	5
accuracy			0.91	23
macro_avg	0.93	0.90	0.91	23
weighted_avg	0.92	0.91	0.91	23
ACCURACY: 0.913				

It is noted that the accuracy of the model is 91.3%, a high accuracy which is worth keeping as one of the final models for these data. The fields related to the project's opinion were processed, specifically 'Urban_Infrastructure', 'Environment', 'Local_Economy', and 'Comment', and the target variable was 'Project_Label'. However, it is important to note that the moderate size of the dataset limits the potential for in-depth analysis and complex algorithms, thereby constraining the variety of algorithms and areas available for testing.

5.5 Summary

This chapter presented the implementation of the empirical work based on the proposed methodological framework through the case study of the Tirana Riverside Project. The initial discussion of this chapter, focusing on the level of citizen participation in the urban planning process in Tirana served to create a clear understanding of the current local context, which was further analyzed in the framework of two specific case studies. Through the analysis of the citizens' and experts' opinions in an NLP-based system, this chapter demonstrated not only the potential of such techniques for overcoming language limitations but also highlighted the importance of considering these two parties who play a key role to the successful implementation of urban policies and projects. Further, the results of this methodology implementation in a real urban context are interpreted in the subsequent chapter, which focuses on the analysis and interpretation of the results obtained through ML algorithms.

CHAPTER 6- Results and Interpretative Analysis

This chapter presents the results of the analysis conducted on the citizens' and experts' opinions expressed on social networks for the Tirana Riverside Project. Through the application of ML algorithms and AI mechanisms, the study has produced a series of results that are not interpreted solely on the technical side but are based on citizens' and experts' perceptions of various aspects of the urban project. These findings provide insights into how different urban issues are perceived mostly by citizens and to a lesser extent by experts, thereby linking technological analysis with the reality of participation in urban planning and decision-making processes. The chapter concludes with a comparative analysis between the perceptions of citizens and experts, which deepens the interpretation of the results and makes the empirical work more precise and meaningful for the purposes of this research.

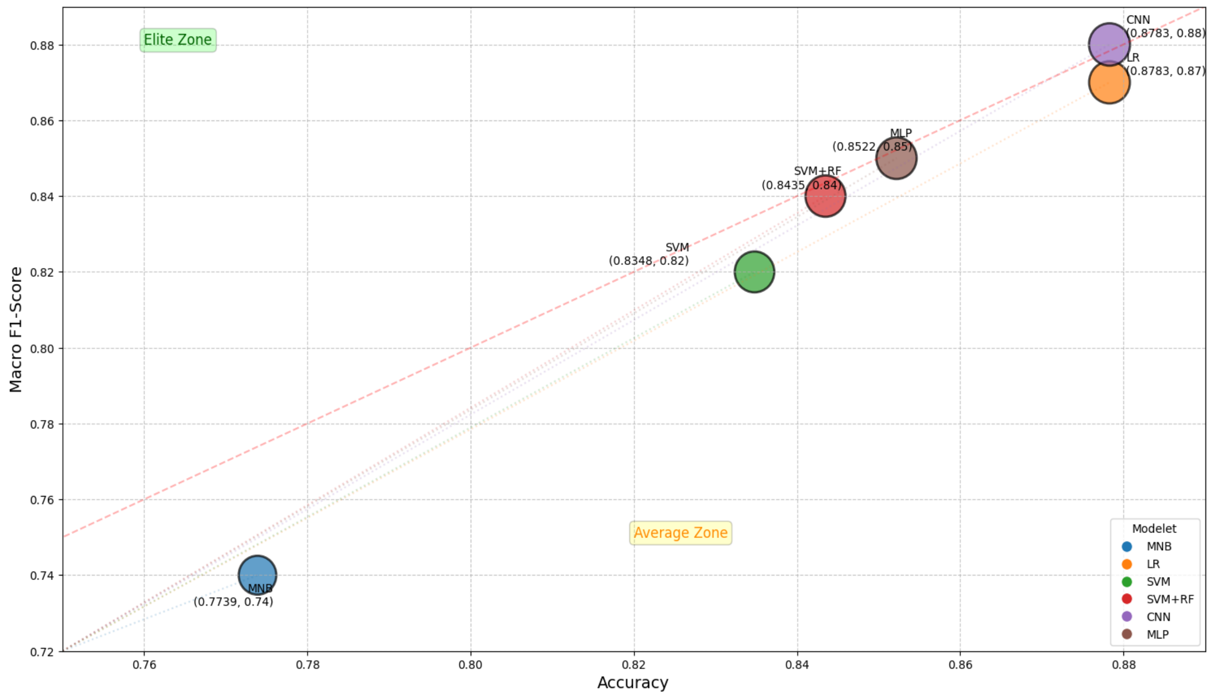
6.1 Analysis of citizens' perceptions

This section includes descriptive, predictive, and interpretive knowledge, such as the identification of dominant themes in public opinion, perceptions based on residency status, geospatial analysis, etc., that contribute to a more profound understanding of citizens' perceptions regarding the project in the case study.

6.1.1 Comparative analysis of algorithms

At the end of the algorithmic approach, it is observed that in the case study, algorithms that have the capacity to identify non-linear relationships and sentence structure have higher performance. The algorithm with the highest accuracy was CNN and LR with an accuracy of 87.83%. CNN as an advanced DL algorithm, with the ability to capture complex language patterns, achieved a value of 88% for macro F1 score which indicates a high level of balanced performance for all classes. LR also achieved a high macro F1 score (87%) and a very good balance of precision and recall for all three classes, especially for Class 1 (positive) where it achieved a recall of 96%. The graph below illustrates the accuracy in relation to the macro metric F1 score for all algorithms, to get a clearer picture.

Graphic 12. Algorithms accuracy vs balanced accuracy



From the results obtained, shown graphically by the classification report, confusion matrix and the graph above, it is concluded that CNN is more suitable for performing in-depth semantic analysis, while LR is more suitable in cases where the identification of data categories/classes is the key point of the task. It is essential that, depending on the nature of the data and the intended objective in data analysis, the most appropriate models be selected to proceed further in real applications. As a conclusion, it can be said that in 88% of cases the model correctly identifies whether a citizen's opinion is positive, negative or neutral. However, the actual distribution of opinion in the test data was 49.6% positive, 25.2% negative and 25.2% neutral. Table 21 shows the best algorithms and their ability to capture each class.

Table 21. Algorithms recall comparison

Model	**Accuracy**	**Recall (neg-0)**	**Recall(pos-1)**	**Recall(neu-2)**
LR	87.8%	79%	**96%**	79%
CNN	87.8%	**97%**	84%	86%
MLP	85.2%	83%	89%	79%
SVM+RF	84.3%	79%	89%	79%

The model has a satisfactory balance between classes overall, but if the focus is on positive classes, the LR algorithm is more optimal; otherwise, CNN should be chosen.

6.1.2 Descriptive and predictive analysis

To maximize the data's potential, further analyses were done. The performed analyses serve to understand and interpret the collected data in more detail, since they represent the opinions of citizens, which makes the issue that is the subject of the study even more sensitive.

a. Identification of dominant themes in citizen discourse

A valuable analysis involves examining the words most frequently used by citizens. This analysis serves as a valid preliminary assessment of citizens' opinions on their main concerns and priorities. The visual result from the content analysis is displayed in the graph below.

Graphic 13. Most frequently used words in dataset

The citizens' most-used words graph shows that they value the information process. This analysis was done on the entire dataset, with the fields related to participation and the project.

The results show that the most frequently used words are related to the aspect of participation. The words 'informed', 'need', etc. show that citizens have most emphasized the need for information. While the words 'not at all', 'very', and 'important' are related to the degree of importance of certain aspects of the project. The mention of social networks illustrates the role that these media have played as a very effective communication channel to gather citizens' opinions. Since information is the dominant theme in this case, it shows a lack of transparency towards residents and citizens in general. Therefore, possessing this knowledge in advance or even in real time can serve to help develop more inclusive policies and be sensitive to the needs of citizens.

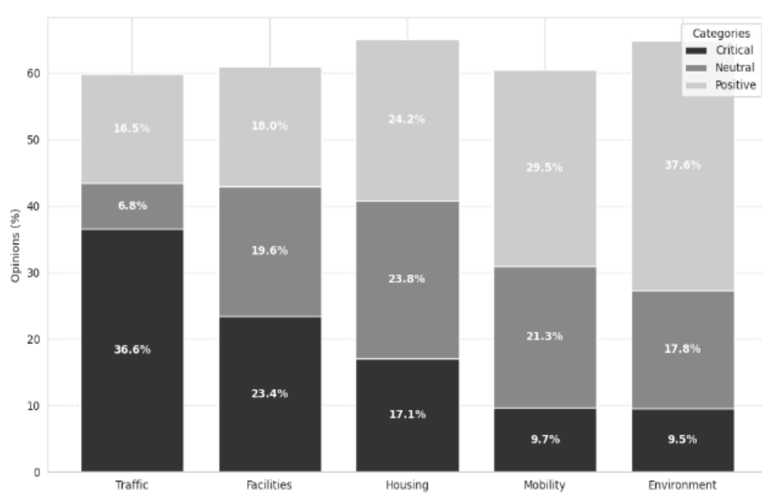
b. Critical evaluation of urban project aspects from citizens' perspective

To understand more about citizens' opinions about the project in question, it is important to identify its most critical aspects. Timely identification of the most critical aspects of the project, through public opinion, can be a key factor in its long-term success. Citizen opinion can often be surprising and even has the potential to reveal new aspects of the project that sometimes only the people directly impacted can perceive. Urban planners can improve the project or develop new strategies to achieve resident acceptance by detecting these new or unplanned aspects. Especially in this case, which concerns dispossessed residents. For this reason, a detailed analysis of the project areas was made through Python codes. The graph shows the distribution of responses (positive, negative and neutral) of all project areas in relation to the total responses received for all areas together. In short, Graphic 14 illustrates which areas contributed the most to the overall assessment of the project (taking into account positive, negative and neutral assessments).

The graph shows that negative responses for 'Traffic' account for 36% of all negative responses received from all fields combined. While within the field, 61.2% of responses are negative.

This high percentage indicates that citizens are concerned about the consequences that such a project could bring, which would affect many residents in terms of worsening traffic in the area. Traffic in the Tirana area is a periodic problem. Specifically, a series of interventions have been carried out in the infrastructure; new road networks, such as the ‘Unaza e madhe e Tiranes’, have been built to ease traffic, but despite the improvements made, the problem continues. Citizens' concern about traffic in this area is an indicator that this aspect needs greater attention in the proposals provided by the project.

Graphic 14. Critical evaluation of project aspects based on citizen responses



The next domain after the traffic issue is ‘Facilities’, which relates to the question, “Do you think the concept of a ‘15-minute city’ (where all essential services are within a 15-minute walk) is achievable in this community?”.

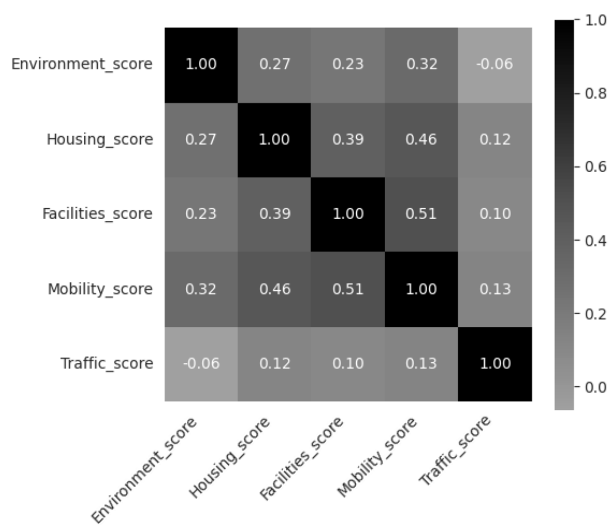
From the results, it seems that citizens do not have much faith in this aspect presented in the project. This distrust may stem from the residents’ lack of involvement in the planning process and the incomplete information provided to them, particularly for those directly affected by any drafted policy.

c. Interdependency of urban project dimensions

When working with data, especially sensitive data collected from citizen opinions, it is important to understand how the perception of one area of the project can impact the assessment of other areas. From an analytical perspective, such an analysis is particularly valuable for generating predictive models for different projects. Furthermore, an analysis of the correlation of fields helps in designing different strategies and policies to improve projects.

In this case, it is noted that the perception of citizens is divided into two different categories: Housing-Mobility-Facilities and Environment-Traffic. The results of the analysis are illustrated in the graph below:

Graphic 15. Project fields correlation



As mentioned, the first category includes the fields of Housing, Mobility, and Facilities, which show a strong positive relationship between each other with a variation of values of 0.39–0.51.

This report indicates that citizens who have a positive opinion about the quality of housing tend to also positively evaluate proposals for mobility (bicycle lanes, etc.) and access to services (and vice versa). The relationship between mobility and facilities is even stronger, with a value of 0.51, indicating that citizens' perceptions of access to public services are closely linked to mobility in the area.

On the other hand, the two remaining fields, traffic and environment, have very weak connections with the fields, especially with each other (with a negative value of -0.06). This indicates that both of these fields are seen as independent of the other aspects.

To obtain the most reliable result, it is important to apply the chi-square test, which determines whether a correlation is random or significant for the model. After applying this technique, the following results were obtained:

Table 22. Chi-square test for fields correlation

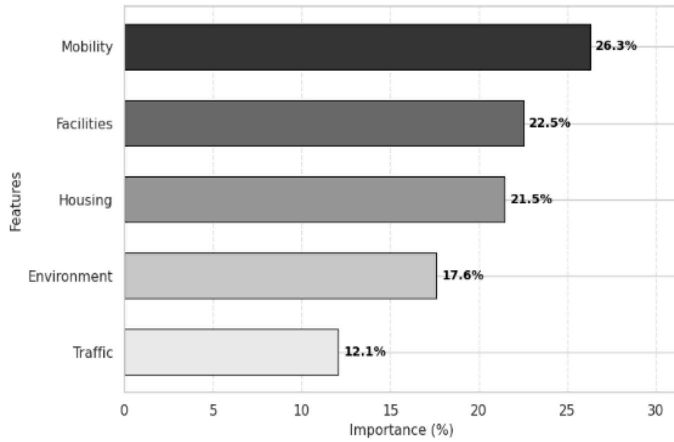
	Environment	**Housing**	**Facilities**	**Mobility**	**Traffic**
Environment	-	0.0000	0.0003	0.0000	0.0097
Housing	0.0000	-	0.0000	0.0000	0.2389
Facilities	0.0003	0.0000	-	0.0000	0.2130
Mobility	0.0000	0.0000	0.0000	-	0.1158
Traffic	0.0097	0.2389	0.2130	0.1158	-

If the value is <0.05 then the relationship is considered statistically valid, otherwise it is considered a random relationship. The table shows a high correlation in almost all areas with the exception of the relations ‘Housing’ – ‘Traffic’ (0.2389), ‘Facilities’ – ‘Traffic’ (0.2130) and ‘Mobility’ – ‘Traffic’ (0.1158). That's why these three are considered random relations, not valid for further analysis.

In conclusion, the results obtained show that improving the quality of housing can positively influence the way citizens perceive mobility solutions and services. At the same time, improving mobility and services impacts citizens' perception of the quality of housing. While traffic is considered a separate issue, not related to the overall quality of the area but requiring dedicated developments and improvements.

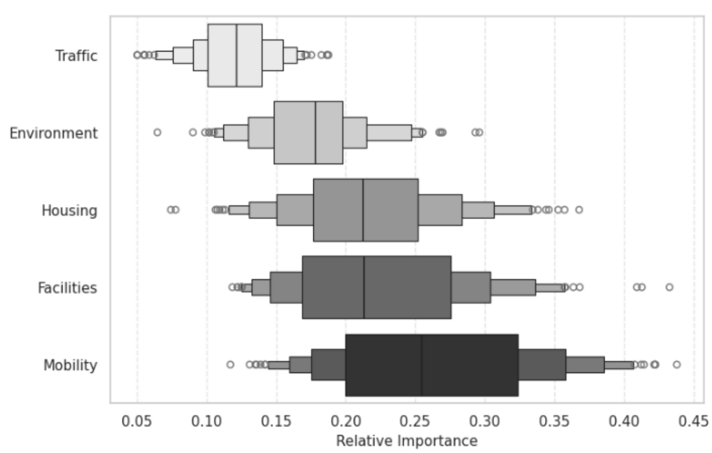
d. Feature variability in citizens perception

Graphic 16. Feature importance across project dimensions



Graphic 16 shows the impact each field has in determining the final evaluation. This analysis helps in detecting the feature that is most important for the model. In ML, features that have more variation are more valuable to the model, as they provide distinctive information for classification. In the case of the Tirana Riverside Project, the most important feature for the final model was ‘Mobility’. This field contributed 26.3% to the data classification. The algorithm that performed the evaluation of these parameters is Random Forest, which builds several decision trees to obtain optimal results. Specifically, the X-plot (Graphic 17) illustrates how this contribution (this importance) varies across the RF model. ‘Mobility’ not only shows a larger impact in the model but also has a narrower distribution in RF, which indicates that this feature contributes consistently across all decision trees.

Graphic 17. Distribution of feature contributions across trees



This distribution shows that citizens' opinions of proposed mobility solutions are a strong indicator for distinguishing projects classified as negative, positive or neutral. Other features, such as ‘Facilities’ and ‘Housing’, exhibit an average level of importance and distribution.

Although mobility is the most important feature of the model, this does not necessarily indicate that it is the aspect that receives the most comments or positive evaluations. But it means that their evaluation varies significantly between positive, negative, or neutral projects. Such variability is precisely what makes it a strong feature for classifying opinions.

In conclusion, the model generated by the RF algorithm used to predict the project rating (Project_label) based on the five data fields showed that mobility has the highest impact on the prediction accuracy. To summarize, unlike other analyses that are essentially descriptive, this one is predictive. And in conclusion, this analysis highlighted that the factors that determine the predictive ability of the model are ‘Mobility’, ‘Facilities’ and ‘Housing’.

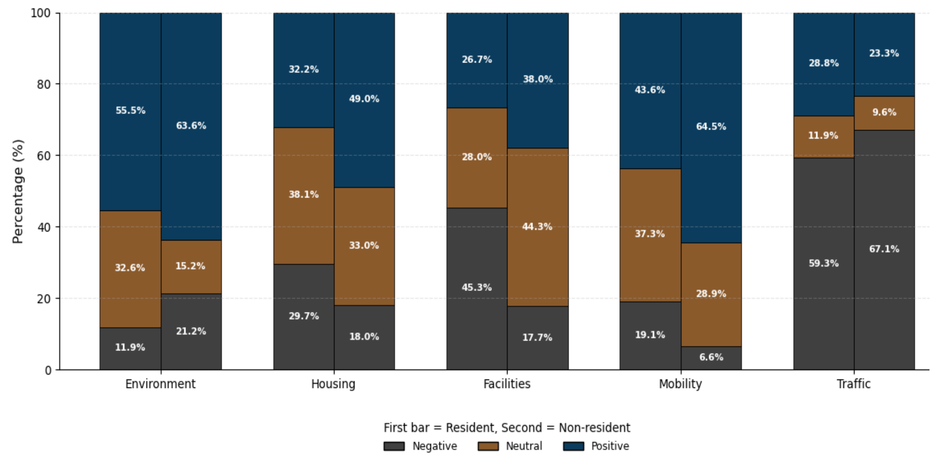
e. Urban project perception across residency status

Place attachment is about the closeness and connection that each person creates with a place, especially with the area they live in. This factor is often regarded as crucial in shaping people's perceptions of various urban projects or issues. People in general tend to evaluate projects or issues that do not directly affect them more coldly, so it was considered reasonable to make such an assessment in the case of the Tirana Riverside Project.

An assessment of the perception of non-resident citizens of that area helps create a clearer and, above all, more certain picture of citizens' opinions regarding environmental aspects, services, mobility, housing, etc. For this, a detailed analysis was conducted for each aspect as assessed by residents and non-residents. The results of this analysis are shown in Graphic 18.

Before analyzing the results, it should be taken into account that the responses received from citizens who are not residents of the area are fewer than those from residents. Although the ratio of non-residents' responses differs from that of residents, it is still valuable to introduce a new nuance in the analysis by developing a more detailed understanding.

Graphic 18. Project perception by residency status



Specifically, the environmental aspect results as one of the areas most valued by citizens in general (especially among non-residents with 63.6%). This may stem from the fact that the green spaces in the former area were not functional for citizens, while the project proposes a well-organized structure for them, especially along the river, which has been a problematic area for years. In terms of housing, residents seem more critical than non-residents. Among the most frequent comments related to housing, the focus is on the quality and standard of construction. Residents are skeptical in this regard, also due to the lack of detailed information about the houses they will receive in exchange.

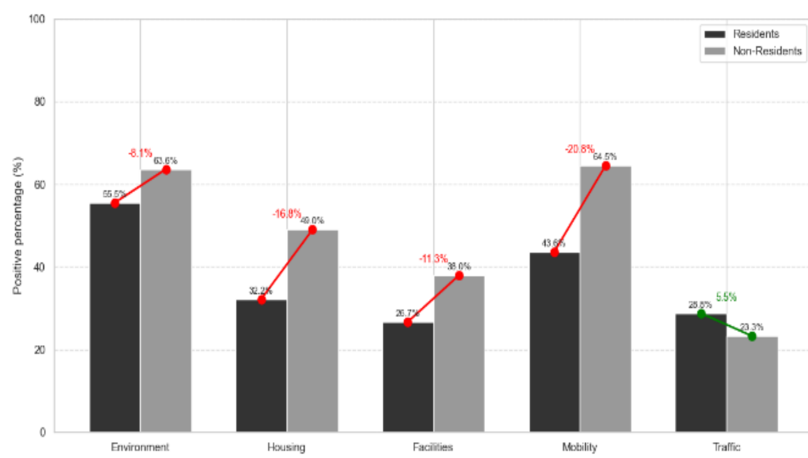
The media has also noted their overall resilience, especially the quality of construction, which has been discussed even recently since some of them have been completed. Mobility has an average rating from both groups.

From the results obtained, the most problematic areas for residents are facilities and traffic. Facilities are related to the concept of the '15-minute city', and the vast majority of residents do not believe in it (45.3%). The planning concept proposed by this project aims to create residential areas designed to meet citizens' needs by positioning services such as schools, health centers, shops, and parks within a 15-minute walking or biking distance. But it seems that there is a high level of skepticism about whether Tirana is ready to implement such a facility.

Both residents and non-residents of this area primarily evaluate traffic negatively. Citizens express concerns about the worsening traffic in the area. Non-residents have an even more negative assessment in this regard, with a value of 67.1%, which indicates that traffic is seen as a major obstacle to the success of the project by all citizens, whether they are residents of the area or not.

While graph below illustrates the percentage of positive responses for each area, it reinforces the previous points by showing that the overall positive perception is generally low, and that citizens who do not live in the area tend to be more optimistic, except regarding traffic.

Graphic 19. Differences in positive perception of the project by residency status



In conclusion, citizens living in the area are more critical of the development and success of the Tirana Riverside Project than citizens from other areas, based on the available data from both residents and non-residents. The very negative assessment of traffic and service facilities shows their poor experience in these aspects. The generated model emphasizes the need for residents' involvement in planning urban spaces and projects, as their perception is more accurate.

f. Geospatial analysis of citizens perceptions by residency status

To better visualize the thoughts and perceptions on the project, a conceptual map was built which shows the geospatial distribution of comments. The map was built using the Python programming language and the Folium library. Folium is a Python library used to create geospatial data visualizations. In this case study, the distinction between residents and non-residents is made in the 'Residence_duration' field. If the value in it is 'I do not live in this area', then the 'Address' field has a specific value. Therefore, a separate dataset was built for non-residents so that the geographic coordinates of each of the citizens' addresses could be added. The geographic coordinates of the residents' area were taken as fixed (the 5 Maji neighborhood).

To convert addresses into geographic coordinates, the geocoding technique was used as follows:

```
geolocator = Nominatim(user_agent="tirana_geocoder")
geocode = RateLimiter(geolocator.geocode, min_delay_seconds=1)
def get_coordinates(address):
    try:
        location = geocode(address)
        if location:
            return location.latitude, location.longitude
    except:
        return None, None
    return None, None
df['Lat'], df['Lon'] = zip(*df['Address'].apply(get_coordinates))
```

Thus, in the new dataset for non-residents, the geographic data Lat (for latitude) and Lon (for longitude) were added next to the address.

After reading the data, the geographical position of the project is fixed, which has a marker that is distinguishable from other areas.

```
project_coords = [41.349251928063254, 19.823657327954262]
tirana_map_cluster = folium.Map(location=[41.3275, 19.8189], zoom_start=12)
```

Then follows the construction of the cluster. The clustering technique was specifically chosen in order to generate a more interpretable map that avoids overlapping points and also shows the density of perceptions in the area. The clustering technique was specifically chosen.

```
class ColoredCluster(MarkerCluster):
    def __init__(self, **kwargs):
        super().__init__(**kwargs)
        self.icon_create_function = """ ... """
```

This functionality allows the numbering of markers by color (where each assessment is marked with a different color) and manages to determine the dominant sentiment. The generated interactive map looks like this:

Figure 64. Clustering non-residents opinions (a) Clustered distribution of opinions by dominant sentiment (b) Individual point distribution of positive, neutral, and negative sentiment

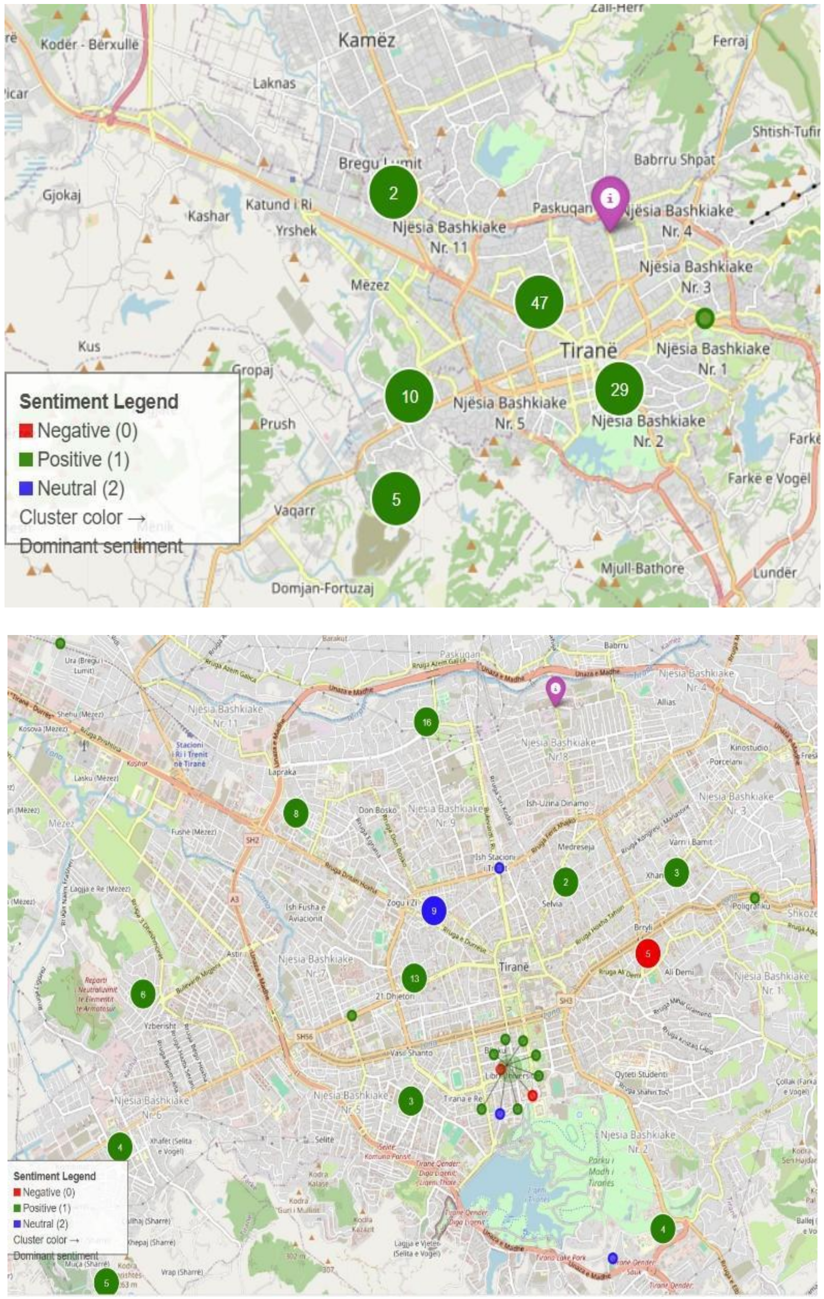


Figure 64 illustrates two different views of the map, where the first shows the dominance class for each area along with the number of comments, while the second shows how these opinions are further clustered (e.g., in the block area there are a total of 10 comments, 2 of which are negative, 1 neutral and the rest positive).

This geospatial analysis indicates that non-residents of the 5 Maji neighborhood have a more concentrated distribution of opinions than residents do. This distribution is evident from the green clusters, which are dominant (positive opinion) in the city's entrance areas leading towards the Tirana River.

However, it should be noted that the number of responses received from non-residents is low compared to residents, and no significant difference in assessment is observed between non-residents based on their geographical location. In this case, the hypothesis linking critical perception to geographical proximity to the project is not confirmed, according to which citizens who are not residents of the area would exhibit more critical attitudes the closer they live to the project. Whereas the perceptions of residents and non-residents are distinctly different, as argued in the previous section. In this case, the focus is only on non-residents to identify a pattern in perception in relation to their geographical position. Based on the interactive map created with non-resident data, it is not possible to identify a specific model that represents the perception of citizens outside the Tirana Riverside Project. As noted, residents' assessment of the project is much more negative than that of non-residents, but it cannot be concluded how distance affects non-residents' perception of the project. This condition may be due to several reasons such as:

- The number of responses collected from citizens who are not residents of the area is smaller than that of residents, making the sampling not very valuable for in-depth analysis. This is because this sampling does not necessarily represent the general perception of this group.
- The city of Tirana has a relatively limited urban space, which means that citizens in general are faced with almost the same urban elements of the project.

Regardless, these aforementioned arguments help to further understand the results of the analyses conducted. However, this does not exclude the possibility that differences in perceptions of non-residents, based on their geographical location, may become more pronounced in the later phases of the project, once a considerable number of residents have directly experienced living in the complex and additional responses have been gathered. Further deepening of this analysis would help in:

- For citizens who want to invest or buy in this area
- Researchers can gain a clearer understanding of the factors influencing the results shown on the interactive map, which is based on geographic positions.

- Creating a realistic perception for non-residents who rarely visit the area
- Urban designers need to identify problems in various aspects of the project, including whether intervention is necessary or if more information should be provided to citizens. And this kind of map can help in this direction.
- Most importantly, increasing transparency for the public fosters a more open urban planning process and enhances the project's acceptability.

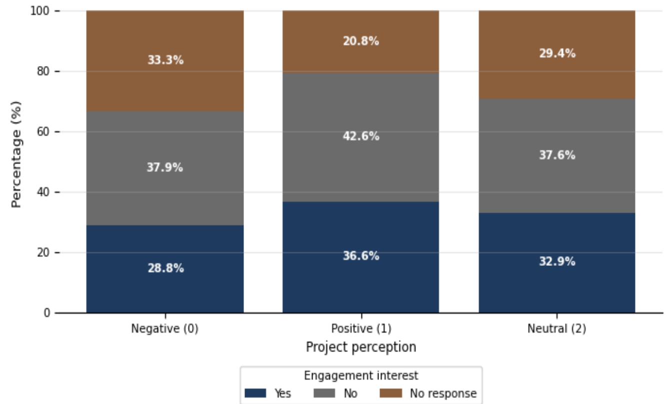
In conclusion, this interactive map serves as an instrument that manages to analyse and communicate the distribution of public opinion on a project. Furthermore, it provides citizens with an opportunity to participate in the planning process of their local area and the city they belong to, promoting a more socially inclusive and sustainable development.

g. Engagement patterns across age groups

One area that has not been included in the project perception assessment and civic engagement analyses is the interest of individuals in participating in project planning or consultations. The question posed for this area consists of the citizens' desire to participate in periodic consultations on project developments, to be part of the draughting of the final plan, etc. In fact, since the plan has already been approved and construction has begun, responses on this aspect have been limited. About 43% did not respond, 31% expressed no interest, and only 26% responded as interested in participating in the process. The high number of non-responses to this question may have come from a lack of interest at this stage, where the project has been underway for several years, or as a result of a lack of trust in the relevant institutions.

However, the analysis continued to explore how interest in civic engagement varies by age group to identify each group’s willingness to participate. Graphic 20 illustrates the relationship between how the project is perceived (as negative, positive, or neutral) and individuals’ willingness to participate in its various phases.

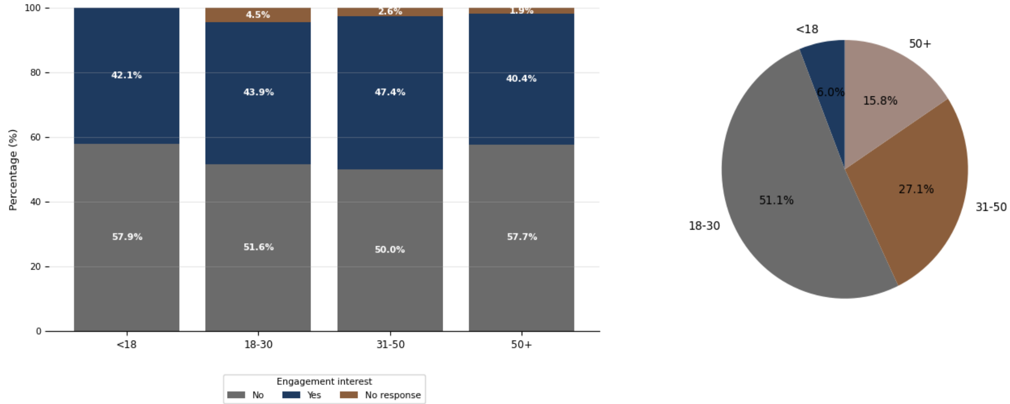
Graphic 20. Citizen engagement interest by project perception



As might be expected, the highest percentage of interest in getting involved is from citizens who have an overall positive opinion of the project (36.6%). However, the analysis shows that although citizens who support the project show more interest than the rest, they also show a higher percentage of refusal to be involved in the project (42.6%).

So, the citizens who are most positive about the project are the ones who mostly refuse to be involved in it. This paradox can primarily be interpreted as a reflection of passivity and a lack of motivation to engage actively in participation. The fact that this part of citizens positively evaluates the project but does not want to be involved even in informative consultations emphasizes the need for a comprehensive strategy, specifically for passive or neutral supporters. Another perspective on the interest shown in participation is related to age groups. For this, a detailed analysis was conducted which shows the interest expressed by age group.

Graphic 21. Engagement interest related to age group



In the first graph showing the % of interest based on age, it is noted that the age groups most interested in getting involved are 31-50 years old (47.4%) and 18-30 years old (43.9%) (see Graphic 21). On the other hand, it is noted that the age groups under 18 and over 50 have the most negative responses. But to reach a more accurate conclusion, an extra graph has been built to evaluate this interest % based on the weight that each of the age groups has in the dataset. For example, if we take the case of the age group under 18, the % of interest shown is high, but this age group represents only 6% of the data available for analysis.

The logical flow shows that the first graph without the analysis added to the pie chart would be incomplete, leading to incorrect results. From the second analysis, it is noted that the most represented age group is 18-30 with a value of 51.1%, followed by the group 31-50 with a value of 27.1%. The distribution obtained from this analysis is crucial for interpreting the results of the first analysis, which only considered the percentage of interest based on age. Thus, a synthetic analysis of these results was developed to make them more comparable with each other and to enhance their interpretability. In this case, the method combines the distribution of responses related to engagement interest across different age groups by applying a standard function to both positive and negative cases, which results in a balanced assessment of these responses. The balanced scorecard calculates the real weight that the answers given have within the respective age group. In short, the following calculation is made:

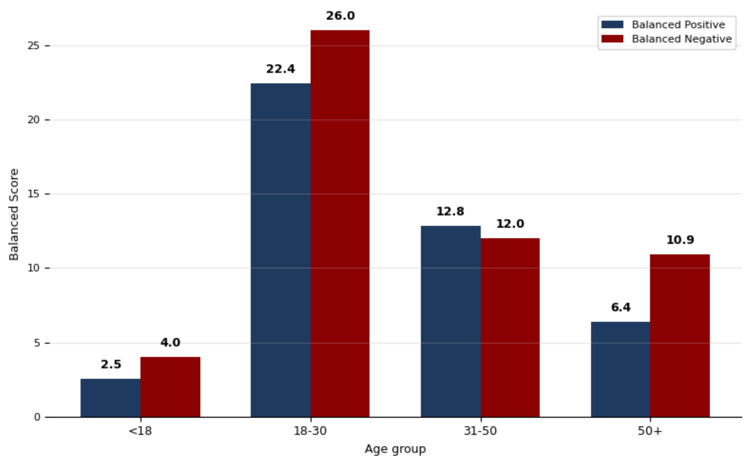
```
age_summary['Balanced_Interest'] = (age_summary['%Yes_in_group'] * age_summary['%Yes_of_totalYes']) / 100
(XV)
```

where '%Yes_in_group' represents the positive responses within the age group and '%Yes_of_totalYes' indicates the weight that this group holds in the total responses.

BPSg=(TotalgYesg×100)×(Total YesYesg×100)/100   (XVI)

The same method was applied to the negative responses in the engagement interest field, and the results obtained are displayed in Graphic 22.

Graphic 22. Balanced positive & negative scores by age group



While the previous analysis indicated that the 31-50 age group was the most interested in participation, this graph shows that the 18-30 age group has the highest percentage of interest because it comprises a larger portion of the total responses received. Furthermore, in the group under 18 years old, which in Graphic 21 had a high percentage of interest, a very small impact is observed in relation to the general data. The same stands for the percentage of negative responses, which shows a noticeable difference in the results obtained.

In conclusion, the most active age group remains 18-30 because it has the highest weight in both interest and refusal to be involved in the project phases (BPS=22.4 and BNS=26.0). The age group 31-50 exhibits a more balanced attitude in this regard, with a positive value of 12.8 and a negative value of 12.0. In the remaining two groups, it seems that among older ages (over 50 years old), negative responses are higher than positive ones, while the group under 18 is more passive and has a very low impact. These results indicate that policies for inclusiveness and transparency should have more focus on these two groups. The results obtained show that this balanced analysis is essential to look beyond the classical results that are more superficial. The balanced analytical approach made it possible to:

- It highlighted the age group that has the greatest weight in overall public opinion (whether positive or negative), which in this case corresponds to the 18-30 age group. Since the 18-30 age group demonstrates a higher level of participation and presents more balanced opinions (positive, negative) regarding engagement interest, it exerts a greater impact on the overall opinion. The over-50 age group contributes significantly to negative responses, possibly due to their resistance to change or skepticism towards the project as a whole.

- This would aid decision-making institutions in identifying the most active groups that are likely to support or oppose a project. The results show that to increase the acceptability of a similar project in the city, policies should focus on the 18- to 30-year-old age group, which has the highest potential for participation. For the group over 50, who have shown more resistance to the concept of inclusion, dedicated and transparent strategies must be implemented to build trust in the relevant institutions. On the other hand, the group under 18, who in this case did not play any role (due to low participation in the survey), must be seen with a long-term, all-encompassing vision to create the idea of shared responsibility.

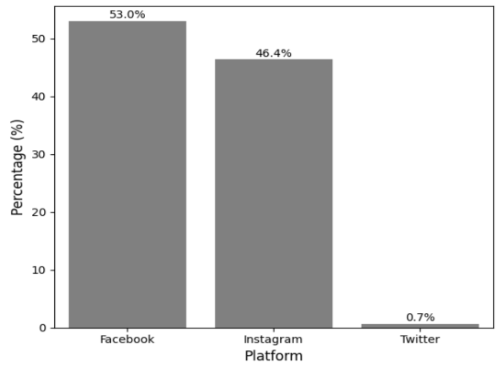
This analysis is crucial because it helps in the decision-making process by identifying key age groups for support, focusing on the most critical and resistant groups for dedicated consultations and strategies, and raising awareness among the most passive groups to encourage their active and continuous participation in a more democratic and free approach to urban planning.

h. Social media usage patterns in urban planning participation

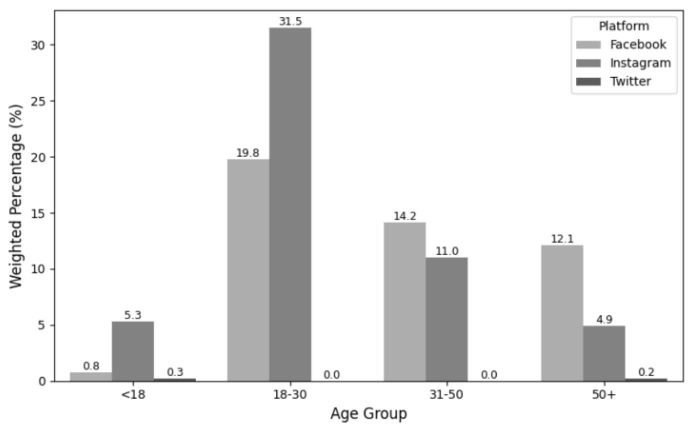
Since social media play a key role in this research by contributing to data collection, it is essential to study them from several perspectives. The questionnaire was distributed on several social media platforms, such as Facebook, Instagram and Twitter, and the number of responses received from each is different. Graph below, showing the distribution of users based on the platforms used reveals that Facebook is the most used social network, with a value of 53%, followed by Instagram at 46.4%. Meanwhile, Twitter, as expected, turns out to be a very little-used network in Albania.

In order for this analysis to be more effective for planners and others, an analysis of the use of these networks by different age groups has also been conducted. The results are illustrated in the Graphic 23. This chart shows that there are strong demographic differences in the use of the mentioned platforms. Those aged 18-30 and under 18 chose Instagram as the network on which they took the questionnaire. Meanwhile, Facebook results as the network most used by those over 50 years old with a coefficient of 12.1, followed by the 31-50 age group. This analysis shows that younger ages prefer to use Instagram more, while age groups over 31, especially those over 50, prefer Facebook, which apparently remains the most popular social network. In conclusion, the choice of communication channel by planners and institutions should be dedicated to each age group.

Graphic 23. Distribution of users across social media platforms



Graphic 24. Platform usage by age group (weighted by original distribution)



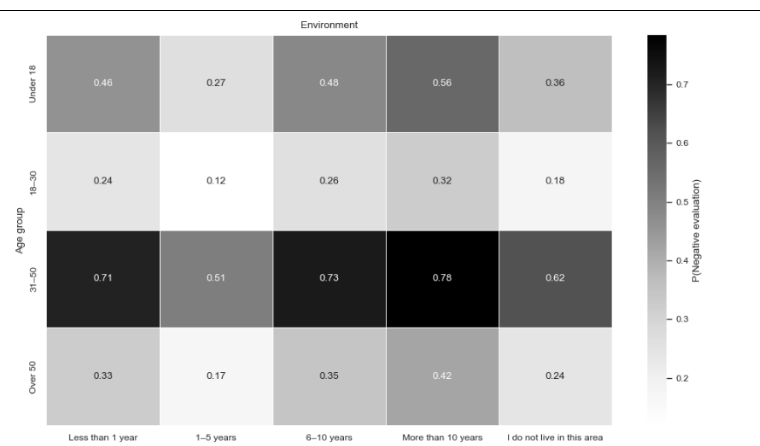
The analysis of whether interest in participating in project phases is related to social network use showed no significant correlation. This conclusion was reached after applying the chi-square method, which studies the correlation that exists between different features (in this case, social networks with the engagement interest field). Overall, it generates a p-value, which in the case of the Tirana Riverside Project was 0.3662. This shows that there is not enough statistical evidence to conclude that the use of different social networks impacts interest in being part of the project. If the value were less than 0.05, then we could reach that conclusion. However, despite the fact that no pattern was found between social media and engagement interest, the analyses conducted on social media in relation to demographics provide valuable insights to increase the effectiveness of public communication.

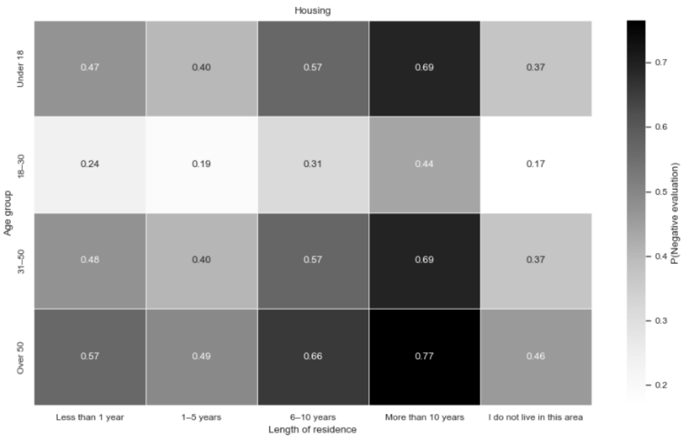
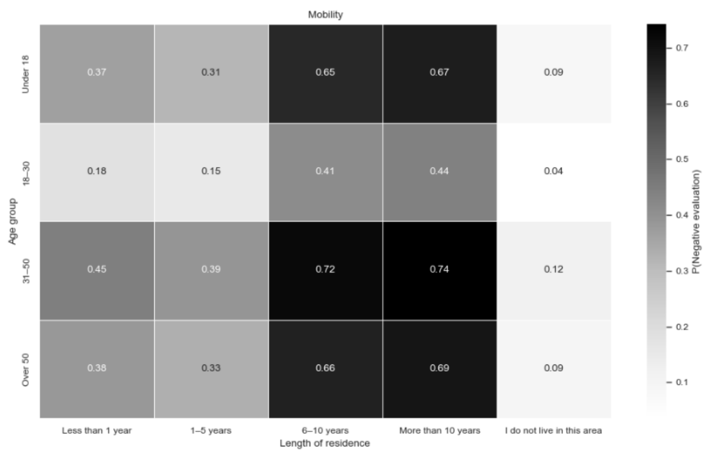
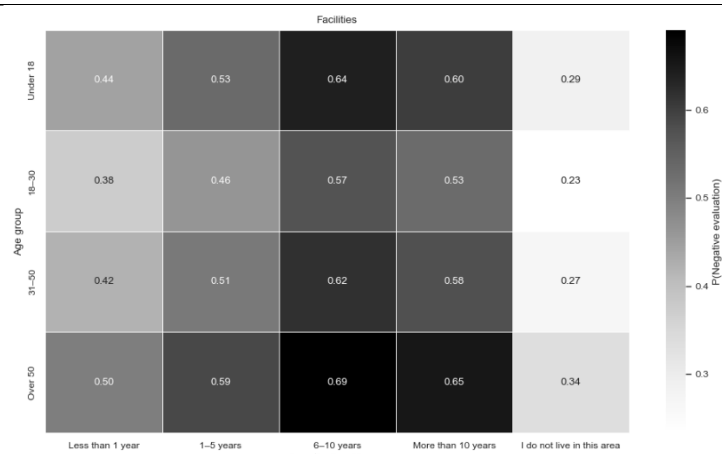
i. Demographic-based predictive risk analysis of urban perceptions

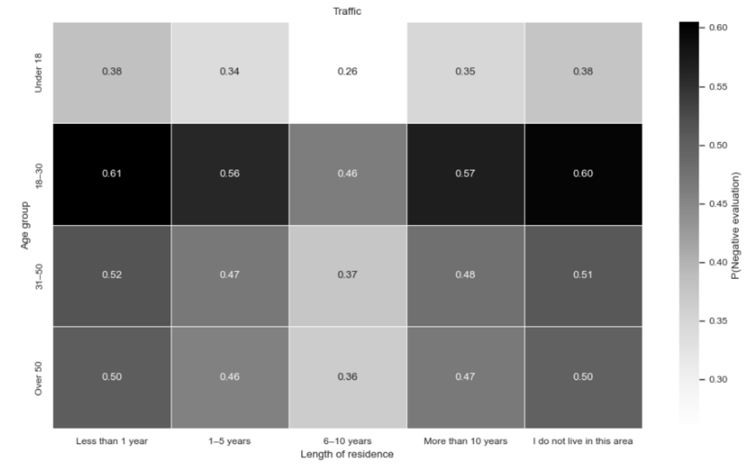
In section 6.1.2 b, a descriptive analysis was conducted that produced information about the project dimensions citizens perceived as most critical, based on a statistical evaluation of the data. On the other hand, one of the greatest potentials that ML has is the ability to predict different situations based on current data. In this section is developed an analysis aimed at predicting the perceived urban risk (the probability of negative perception) by citizens for each of the project areas studied, based on demographic data such as age and duration of residence in the 5 Maji neighborhood. As a predictive analysis, it employs statistical models and ML to identify hidden patterns between citizens' profiles and their evaluations of the various urban dimensions of the project in question. Each of these dimensions has been treated separately to avoid model ambiguities. So at the core of the analysis lies the hypothesis that negative perceptions of different urban dimensions (of the project) are also influenced by factors such as age and duration of residence in a given area (5 Maji in this case). The methodology consists of a series of steps, such as data cleaning, data normalization, transforming responses into numerical values through the response mapping function, binary variable to store the probability of perception etc. Some important steps include:

- Feature selection: `X = df_dim [["Age", "Residence_duration"]]`
- Building the model with the LR algorithm and training it
- For all possible categories of the selected feature, a predictive simulation was performed (i.e., the predicted probability of a negative valuation was calculated).

Table 23. Risk heatmaps of project dimensions

Risk heatmaps	Risk distribution
Environment	{0: 286, 1: 48}
	0.729
Housing	{0: 248, 1: 87}

<table>
<tr><td>
</td><td>0.598</td></tr>
<tr><td>Mobility</td><td>{0: 262, 1: 49}</td></tr>
<tr><td>
</td><td>0.697</td></tr>
<tr><td>Facilities</td><td>{0: 194, 1: 120}</td></tr>
<tr><td>
</td><td>0.726</td></tr>
<tr><td>Traffic</td><td>{1: 188, 0: 120}</td></tr>
</table>

<table>
<tr>
<td>
</td>
<td>0.565</td>
</tr>
</table>

To have a more concrete overview and interpretation regarding the factors considered, heatmaps have been constructed for each of the project dimensions (Table 23). From the table above, it is noted that the models achieve higher performance for ‘Environment’ (0.729) and ‘Facilities’ (0.726), indicating that the perception on these dimensions is more predictable from demographic data.

In the 'Environment' aspect, the probability of a negative rating increases significantly in the 31-50 age group, especially for residents who have lived in the area for a relatively long time (6-10 years or over 10 years). Younger ages and non-residents have a lower probability of rating negatively in this aspect.

The probability of negatively assessing housing conditions increases significantly with both age and duration of residence. This shows that the perception of the need for housing improvement, but also of the environmental aspect, is more pronounced among citizens who have been present in urban changes over time and have lived longer in the area.

Regarding ‘Mobility’, the probability is higher in the age groups 31-50 years and over 50 years, where the duration of residence is long (6-10 or over 10 years).

In ‘Facilities’, a steady increase in negative ratings with increasing age has been identified, regardless of the duration of time lived in the area. This result is more than expected given that older people have more specific needs from public facilities, such as physical access to health services, administrative services, etc.

And as in all other analyses conducted, '<u>Traffic</u>' remains the highest priority aspect. This shows that traffic problems are perceived as issues with a wide impact and not as a local experience.

To summarize, the constructed predictive model demonstrates that demographic factors (age and duration of residence, in this case) contain sufficient information for predicting negative perceptions of various urban aspects. In contrast to descriptive analyses, this analysis enables citizen perceptions to be treated not simply as passive knowledge that assists in the current planning process, but as important instruments for forecasting and strategic intervention for the future.

6.2 Analysis of experts' perceptions

The analysis of the data collected by the experts is more concise since the size of the dataset was smaller than in the case of citizens. However, the analysis conducted revealed several important indicators, including the aspects perceived most critically and the relationship between the project's critical dimensions as viewed by the experts. These insights are valuable for creating a comprehensive understanding of this perspective, and when compared to citizens' perceptions, they help clarify how compatible the results are with reality.

a. Identification of dominant themes in expert discourse

The analysis of the words most used by experts helps in understanding the different dimensions of the experts' perspectives on the project and their involvement in it.

Graphic 25. Dominant terms in the experts' opinions

In Graphic 25, it is noted that the most mentioned words are related to their opinion about the project, which seems to be mainly positive. The appearance of the words "little", "informed", "weak", and "involvement" shows that transparency in information and the level of citizen and expert involvement in the process are conceived as insufficient. Such a linguistic analysis highlights aspects that should be in focus in future policies or strategies, while also aiding in the overall and quick reading of the data.

b. Project aspect criticality & participation: correlation insights and chi-square significance

As with citizens, it is also very necessary for experts to identify the aspects perceived as most critical in the project. From the results of the analyses carried out for the areas belonging to the project (‘Urban_Infrastructure’, ‘Local_Economy’, ‘Environment’) and the areas related to inclusion (‘Participation’, ‘Collaboration’, ‘Knowledge’), the following conclusions were reached:

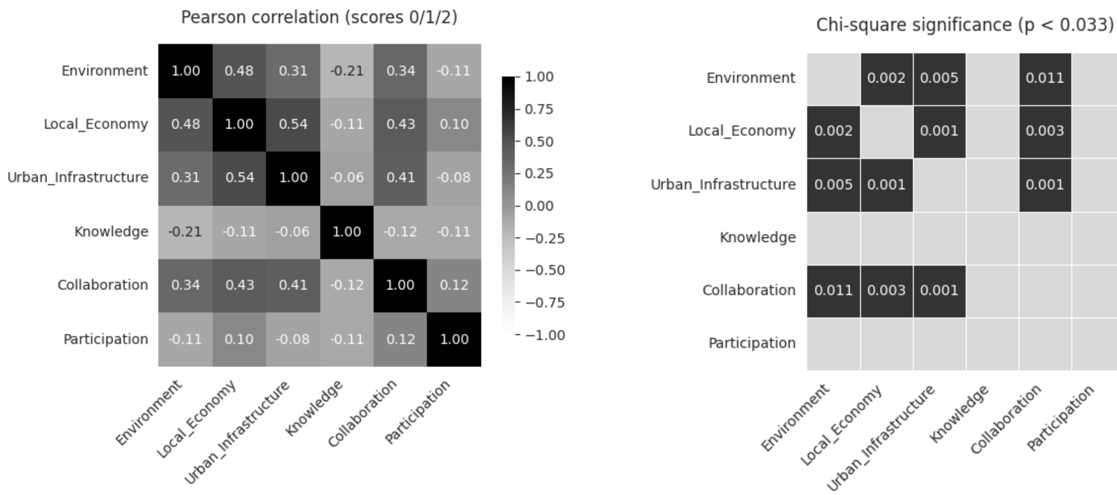
- 68.8% of the responses to the ‘Participation’ field (‘Do you think that citizens and experts have been sufficiently involved in decision-making on this project?’) are negative. This percentage demonstrates that, according to the experts surveyed, the involvement of citizens in various informational, consultation or planning processes has been limited. This result further reinforces the citizens' perception of the issue at hand.
- Between 60% and 70% of the responses in the fields of ‘Collaboration’ (‘How do you assess the quality of cooperation between institutions and experts during the design and implementation process?’) and ‘Knowledge’ (‘How do you assess your knowledge of the Tirana Riverside Project?’) are neutral. But since the answers to these questions correspond to ‘Little informed’ and ‘Average’, this assessment can be seen as negative to neutral. While the other fields are not very critical, especially the fields related to the project, they are assessed relatively well.

To obtain a more in-depth result, a correlation matrix was constructed between the mentioned fields, and it was also assessed whether these correlations are statistically significant, based on a threshold determined with a p-value < 0.033 (see Graphic 26a). The analysis of the correlation between the fields leads to the following conclusions:

- There is a moderately positive relationship between the fields ‘Urban_Infrastructure’ and ‘Local_Economy’ (with a value of 0.54 where the maximum value is 1). The ‘Collaboration’ domain is also associated with a value of 0.41-0.43 with both of these domains. There is also a medium relationship between the ‘Environment’ and ‘Local_Economy’ domains (0.48). The correlation between domains means that when one of these aspects is rated well/badly, the other domain tends to be rated equally.

- Whereas the fields ‘Participation’ and ‘Knowledge’ are seen as completely independent from other fields, as they have negative or 0 values.

Graphic 26. (a)Pearson correlation matrix (b)Chi-square significance



To understand more about these relationships already identified by the Pearson method, the chi-square technique is also necessary, which assesses the quality of these correlations. In the matrix above (see Graphic 26b), the chi-square values for the chosen threshold of 0.033 are illustrated. It is noted that the extracted values confirm the correlations:

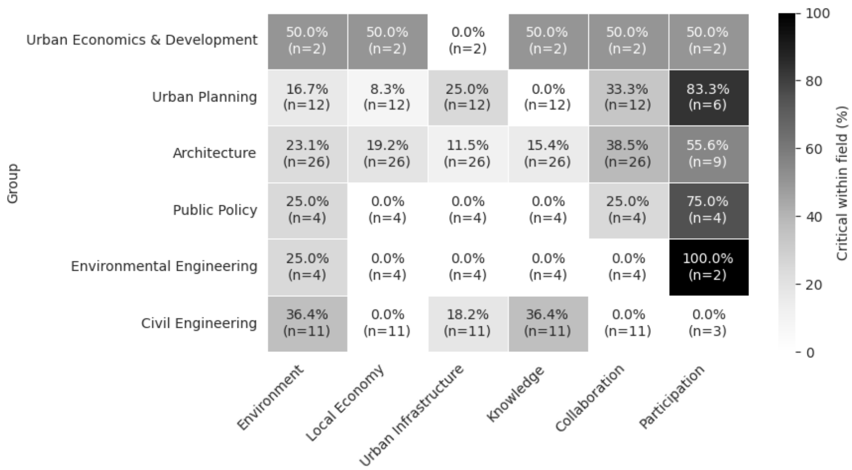
- ‘Environment’ – ‘Local_Economy’
- ‘Environment’ – ‘Urban_Infrastructure’
- ‘Environment’ – ‘Collaboration’
- ‘Local_Economy’ – ‘Urban_Infrastructure’
- ‘Local_Economy’ – ‘Collaboration’
- ‘Urban_Infrastructure’ – ‘Collaboration’

<u>This result in terms of the Tirana Riverside Project can be read in this form:</u>
Perceptions of the ‘Environment’, ‘Local_Economy’, and ‘Urban_Infrastructure’ generally move together in one direction (positive, negative, or neutral); the quality of cooperation also plays a role here but is only slightly related, with a value of 0.34. The levels of knowledge (‘Knowledge’) and civic participation (‘Participation’) do not relate to any of the areas, suggesting that dedicated interventions or strategies are necessary for improving these two aspects.

c. Criticality by field and expert specialization

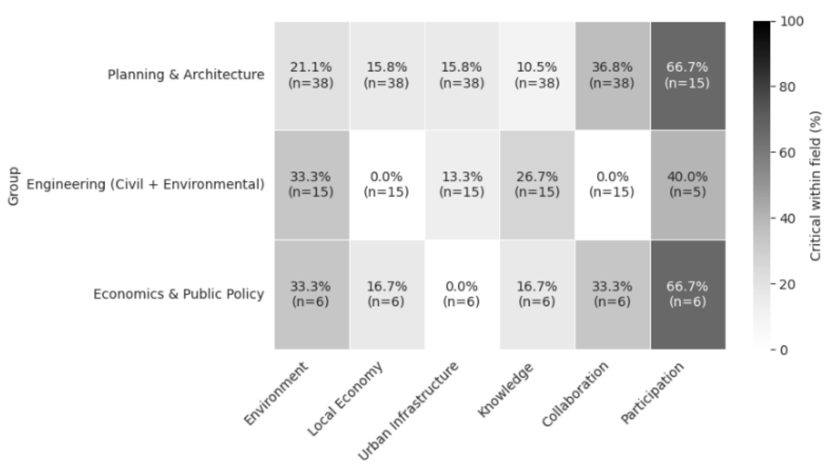
Since one section of the questionnaire focuses on specialization, a valuable analysis would be to determine which areas are considered most critical by experts according to their respective specialization profiles. Thus, the expert opinions for each field were analyzed, and the results were illustrated in a matrix that also indicates the number of samples for each case to prevent misinterpretation of results from very small samples (see Graphic 27).

Graphic 27. Criticality within the field by ‘specialization’



What is noticeable here is that n is relatively small in some categories, and to stabilize the reading of the result, an aggregation of several areas of specialization was done. Even after aggregating the fields as in Graphic 28, it is again noted that ‘Participation’ (involvement of citizens and experts) remains the most critical issue across all types of experts specialization. The quality of cooperation with institutions is also a critical aspect, according to urban planning and architecture experts.

Graphic 28. Criticality within the field by ‘specialization’ (aggregated in three groups)



The analysis done for some of the specializations is based on very small samples and therefore is not sufficient for statistically strong conclusions but shows alarming signals for criticalities. In order to reach a conclusion for them, a broader verification with more data is needed. Therefore, the results obtained are indicative data but not final.

However, areas that should be prioritized have been identified, such as developing new effective mechanisms for inclusion (especially for planners and architects) and building capacities for intersectoral cooperation.

6.3 Comparative synthesis of citizens' and experts' perceptions

These perspectives, as a simple citizen residing in that area or in an area within the capital, and as an expert involved or not in various forms, provided a more complete and detailed view of the main aspects of the project. The potential offered by ML and AI in the processing and analysis of collected data brought a series of conclusions regarding the Tirana Riverside Project, such as:

- Models generated by CNN and LR algorithms in 88% of cases manage to accurately identify citizens' opinions, but depending on the intended objective, a selection can be made between them.
- The analysis of the project areas concluded that traffic was the most critical issue, accounting for 36% of all negative responses received across all areas. The '15-minute city concept' emerged as the next most critical area.
- In analyzing the potential relationships between the fields, a significant correlation was found among Housing-Facilities ('Facilities' is related to the '15-minute city' concept) and 'Mobility', with a variation ranging from 0.39 to 0.51. This connection is interpreted in this way: improving the quality of housing can positively impact citizens' perception of mobility and the facilities offered. Also, facilitating mobility can affect citizens' perception of the quality of housing. On the other hand, traffic is a completely independent issue.
- Predictive ML analysis using the RF algorithm identified 'Mobility' as the most impactful area for the model. In short, the accuracy of the forecast model is most affected by the assessment of 'Mobility'.
- The study examined how citizens' areas of residence influenced their perceptions of each project area, concluding that the environmental aspect is one of the most valued. Conversely, both residents and non-residents place the highest negative value on traffic.

- The interest in being part of the project's information or planning consultations is highest among citizens who have a generally positive opinion of it (36.6%). However, the highest percentage of refusals to participate comes again from citizens who perceive the project as generally efficient. This paradox is explained in detail in the relevant analysis section.
- Based on the analysis of age groups, the most interested in being active in participation have been identified as the 18-30 age group. Following them is the 31-50 age group, which presents a more balanced interest. Meanwhile, the younger age groups (under 18) and the older ones (over 50) show very low interest in this direction.
- The analysis of social media usage patterns revealed that 53% of users primarily used Facebook. But there are strong demographic differences in the use of these platforms based on age because Facebook is most used by the over-50 age group, followed by the 31-50 age group. Instagram is more popular among younger users.

All these results are argued in more detail in the relevant sections above. Almost all of these analyses are focused on the evaluation of the project and other areas left out of the labelling, such as interest in participation, age, address, etc. This is because the evaluations made about the participation process are generally negative. The table below shows the percentage of citizens' assessments.

Table 24. Project and participation evaluation

	'Project'	**'Participation'**
Positive opinions	45.8%	7.6%
Negative opinions	33%	92.4%
Neutral opinions	21.2%	-

It is noted that for the field of 'Participation', about 92% of the responses are negative, meaning citizens express themselves as 'Not very informed' or 'Not informed at all'. Meanwhile, the evaluations of the project are mostly positive. This gap between the project evaluation (in this case, is the output) and the process evaluation (information and involvement) shows that citizens generally accept the changes brought about by the project but are not properly informed or do not feel part of the decision-making process. This may have been one of the main causes of their resistance, even in cases where such an intervention and transformation of the area is considered positive.

Therefore, collecting such data through social media offers great potential for in-depth analysis of the situation, as citizens feel freer to express their opinions. This research has identified the most critical aspects of the project, including the age groups that are most and least interested in participating, the most effective communication channels, and the issues that citizens frequently perceive as interconnected. These findings suggest that real-time interventions could enhance project acceptability, improve various aspects, increase transparency, and develop dedicated communication and inclusion strategies.

As for the analysis of experts' opinions for the project, the most appropriate model was generated by the SVM algorithm with the TF-IDF method for vectorization, with an accuracy of 91%. It should be noted that due to constrains in data volume, complex analyses could not be performed. However, based on the methodological approach used, it can be said that:

- The most critical issue for experts regarding the Tirana Riverside Project is 'Participation', with 68.8% negative ratings.
- Perceptions of the environment, local economy, and urban infrastructure generally move together in one direction (positive, negative, or neutral); the quality of cooperation also plays a part here but is loosely related, with a value of 0.34.

Although these cannot be called definitive data, they are exploratory data and, above all, indicators that have identified issues that should be a priority for institutions and decision-making bodies in planning. Comparing the opinions of citizens and experts leads to the conclusion that inclusion is a problem hindering the project's development and long-term success. Thus, the design of new, comprehensive, innovative and, where necessary, dedicated policies become a necessity to ensure that the process is as credible and transparent as the outcome.

CHAPTER 7- Conclusions, Contributions and Recommendations

7.1 Conclusions

The main goal of this research was to develop a participatory planning model that, through the analysis of data collected from social networks, enables more responsive decision-making by positioning citizens as primary stakeholders in urban issues. This objective was grounded in the Albanian context, a country where citizens' opinions are often undervalued, despite ongoing reforms and aspirations for European Union integration.

In response to the *main research question*, the findings showed that participatory planning can be achieved through the effective combination of data collected from social networks with ML and AI on daily urban issues that directly affect the lives of citizens. Social media, due to their spontaneous nature and wide-ranging participation, enable the collection of real data that, when analyzed and integrated into a structured institutional framework, can provide valuable contributions to decision-making.

To address the first research sub-question*, how citizens and experts perceive participation in the urban planning process in Albania*, the empirical findings on the Tirana Riverside Project pointed out the need for a planning model that listens to and integrates the voices of citizens. The analyses conducted show that citizens feel completely excluded from the decision-making process and have lost trust in the policies and urban interventions undertaken. This finding is further reinforced by the analysis of experts' data, which reveal that citizen participation remains at minimalist levels and in bureaucratic processes that do not produce any results in this direction. Consequently, the project demonstrated that citizens' resistance is not to the development itself, but to their exclusion and the absence of clear, trustworthy information (participation: 92% negative responses; project: 33% negative responses).

Regarding the second research sub-question, *how social media platforms serve to collect data from citizens and experts on urban planning issues and projects*, this research demonstrated that social networks are a crucial tool for understanding and interpreting citizens' perceptions of various urban projects or issues that directly affect them. By using traditional data collection methods like questionnaires, along with social media to share them, it is proved that this methodological approach effectively gathers context-sensitive opinions that are often missing from official planning processes.

In addition, it is important to note that, despite the limitations caused by the lack of NLP libraries for Albanian language processing, the practices developed specifically for this system enabled a complete analysis. A conclusion drawn from this workflow is that ML as an integral part of AI has the potential to outperform and perform descriptive and predictive analyses with high accuracy even in situations where parts considered important to the pipeline are missing. It is precisely this accuracy and performance of the generated models that answers the third research sub-question about *the contribution of ML and AI techniques to participatory decision-making in resource-constrained languages*. Consequently, it can be asserted that this proposed methodological framework is transferable to similar urban contexts where technological and institutional limitations are encountered.

To summarize, as noted in previous chapters, Tirana is a chaotic city with very spontaneous urban planning, but it has the potential to develop strategies and mechanisms with clear objectives to promote a sustainable and democratic development of the city. In this research, only one of the urban projects that aroused resistance and public reaction was taken as the main case study, and the results indicated that social networks offer a powerful information channel, which, if used by urban planners and institutions due to their spontaneous nature, significantly helps in responsive decision-making that represents the demands, needs, and priorities of citizens. It is true that this form of communication also has its limitations and challenges, but if it becomes part of a structured, institutionalized model with concrete rules, it will constitute a critical instrument for urban planning. To ensure that this form of participation does not remain incomplete at the level of data collection, it must also serve as a platform for providing feedback to citizens, thereby increasing transparency in the processes conducted. In conclusion, developing innovative strategies and mechanisms to enhance citizen participation in Albania is essential not only for increasing the legitimacy of policies aligned with European Union practices but also as a fundamental demand from citizens.

7.2 Synthesizing theoretical frameworks and empirical findings

This section aims to connect the results achieved in the empirical part of the research with the theoretical concepts discussed in the second chapter. By comparing the case study findings with the participation models and planning approaches discussed in this research, it is possible to increase the understanding of how these conceptual theories function in the Tirana urban context. Specifically, in this research, several reference models have been used, including the Arnstein (1969) Ladder of Participation to assess the extent of citizen participation, Dalal-Clayton (1993) forms of participation to determine the current form of participation, Jacobs (1992) and Scott's (2020) theoretical perspectives against the top-down planning approach without bottom-up initiatives, etc.

Thus, the case study data analyses results show that citizens were not involved in the planning process, which is linked to the resistance against this project. This finding is consistent with Sen's (1999) argument that asserts that genuine public engagement is essential for the formulation and implementation of development strategies; in its absence, development policies tend to become unsustainable and may encounter significant resistance from the community.

Based on the context of urban planning in Tirana and the participation typologies proposed by Dalal-Clayton (1993), institutions currently adopt a passive approach to urban planning. It is considered a passive form since the initiatives and policies undertaken do not constitute a genuine mechanism for communication, dialogue, or interactivity with citizens. Furthermore to connect to this research core, as demonstrated in the previous chapters, aside from the symbolic forms of participation outlined in the relevant regulations, the data generated by social networks and other online platforms often are not subject to any official systematic analysis by institutions or urban planners. These instruments are mainly used for the dissemination of information, remaining a passive process often used for political purposes. If examine this situation through Arnstein's (1969) model, citizen participation in urban planning in this city falls at the level of tokenism. According to Arnstein, at this level citizens receive information and can take part in participatory initiatives such as public hearings, but they do not have institutional mechanisms to ensure that the opinions expressed are considered. In other words, the planning practices in Tirana demonstrate that participation is symbolic and the procedures are used to show transparency but not real power in decision-making.

The results of the ML analysis for the Tirana Riverside case study (presented in Chapter Six) demonstrated that there are issues and dimensions to the project that, although initially seeming secondary, significantly influence citizens' perceptions and may even be a priority for them. The main conclusion that emerges from that is that, if institutions and urban planners were to develop such comprehensive analyses, the legitimacy of the project would increase and consequently transparency would positively affect citizens' credibility and acceptability. All of this ties into Jacobs's (1992) critique of the top-down approach, emphasizing the importance of its "eyes on the street" principle. In addition, it is also related to Scott's (2020) theory, which emphasizes that decision-making institutions, by generalizing urban contexts through rigid planning methods, often face problems that have not been taken into account in previous steps of the process. In this research, through the methodological approach followed, it is demonstrated that this problem can be avoided by ML analyses, which enable real-time monitoring of problems, citizens' priorities, and even their prediction.

To understand how citizen participation can be concretized in practice based on the proposed methodological framework, the **New Oregon Model** (2007) can be used, which offers a cyclical approach to analyzing citizen participation processes. Thus, in the Albanian setting, it can be contextualized as follows:

The question, *"Where are we now?"* was explored through data analysis, thereby enabling real-time monitoring of the current urban situation, which reflects the actual needs of the community—needs that are often overlooked in official planning processes. As previously mentioned, the interpretation of the findings show that citizens feel excluded from decision-making processes and that their trust in institutions is relatively low. But on the other hand, the lack of a negative correlation towards the project as a whole suggests that resistance to it is mostly related to the lack of citizen involvement in the process. In this context, it is concluded that non-participation is a fundamental factor in the citizen's attitude towards urban projects or policies, thus confirming once more Sen's (1999) argument.

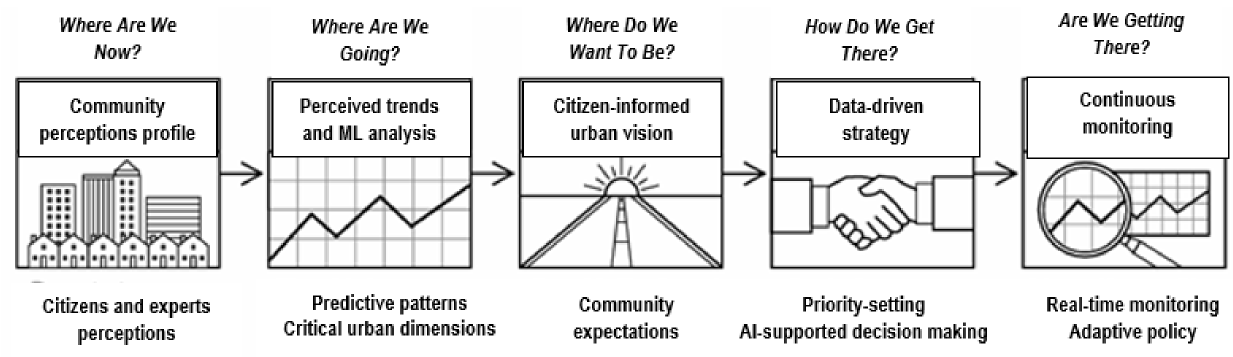
Empirical findings derived from the predictive and descriptive analyses also address the question, *"Where are we going?"* These findings indicate that citizens mostly express concern about the traffic and facility dimensions of the project, reflecting distrust towards the concept of the '15-minute city'. Citizens' greater concern about these two dimensions suggests that the development of the infrastructure system needs fundamental improvements. Furthermore, from the demographic-based analysis for risk assessment, it was highlighted that even though the profile data for citizens were minimalist, they were still sufficient to predict the negative attitudes of citizens towards concrete aspects of the project. Overall, the proposed methodological framework demonstrates the capacity of ML and AI techniques by leveraging social media as a source of real data to answer this question.

"Where do we want to be?" - The urban vision in Albania is usually framed in bureaucratic procedures and formal documents, and, based mainly on the evidence generated through the case study analyse, it becomes evident that a common vision of urban development is missing. This concept gains particular significance in the Albanian context, which is a developing country aspiring to become part of the EU membership. The empirical findings underscored the necessity of involving citizens in the planning and decision-making processes through a well-defined model to enhance their motivation by acknowledging their voices. In this context, the urban future that citizens desire is one in which they play an important role in shaping urban policies and projects that influence the development of the city they are part of and consequently directly impact their quality of life.

In the question *"How do we get there?"* the answer is interpreted through concrete findings from the empirical work that support the achievement of the goals set in the previous question. Analyzing citizens' opinions in a medium where they express themselves spontaneously enables the identification of several hidden aspects of the project. The identification of the most critical project dimensions, the relationships between these dimensions as perceived by citizens, the groups most resistant to change and the more passive ones, and the patterns of social media usage based on demographic profile helps in establishing the steps required for the design of an innovative urban strategy grounded in the real demands and needs of the community. In this way, citizens are able to influence decision-making processes indirectly in a spontaneous manner.

The final question, *"Are we getting there?"* can be answered through the potential offered by ML for monitoring citizens' perceptions in real time. This approach offers a comprehensive interpretative mechanism for assessing how different policies or projects are received by the public and what their actual experiences are, ensuring full transparency in achieving the objectives set at the beginning of the process. However, it is worth noting that to have a definitive answer to this question would require the formal adoption of the proposed methodological framework by the relevant institutions within a continuous period of time, given that visioning is an iterative and ongoing process. In Figure 65, the scheme of the Oregon model is reconstructed, based on the context of this research.

Figure 65. Adapted New Oregon Model



Note. Data source: (Steiner & Butler, 2007)

Addressing the fundamental principles of the New Oregon model through empirical findings and the proposed methodological framework demonstrates that the main pillars of building a shared community vision can be effectively achieved, even in contexts where citizens' voices are undervalued, by strategically leveraging social media and AI. Overall, it is evident that the urban planning system in Tirana needs to establish a clear and well-defined standard that explicitly specifies the role of citizens in the formulation, discussion, and evaluation of urban plans and projects.

7.3 Methodological contributions

The methodological approach used in this research is a special pipeline in the absence of ML functionalities for data processing in the Albanian language. Thus, this process constitutes a unique comprehensive framework, developed through a logical flow based on ML and AI that integrates two different perspectives on the perception of an urban issue, making this methodological approach a new and valuable contribution to similar urban contexts. The language resource limitation specifically resulted in the development of a workflow that directed the data collection process towards more traditional methods, such as questionnaires, to maintain 'sub-control' over the manageability and natural language processing of the data flow. Thus, through questionnaires, it was possible to keep the data at a manageable level (since the ML steps would be carried out by external scripts specifically designed for this purpose). Social networks not only played a crucial role in distributing and receiving a large number of responses but also functioned as a genuine communication channel, where the responses were concrete and closely aligned with Albanian reality.

Tirana was selected as a case study due to the persistently low levels of citizen participation and the ongoing challenges in its urban development processes. In this context, research through this case study aimed to demonstrate that the effective use of ML, AI and social media with a far-sighted vision for the advancement of the city helps overcome these challenges. The strongest point of this methodology lies in the fact that it is new to the Albanian context and in the integration of ML and AI in urban planning for citizen participation. However, it is worth mentioning that the presence of Python libraries for language processing and a higher number of responses from citizens and experts would have generated even better results and more in-depth predictive analyses.

7.4 Contributions of the research

This research offers a theoretical contribution to participatory planning by reconceptualizing it within the framework of a collaborative, data-driven ecosystem. The proposed model, unlike the traditionally followed models, presents an entirely different approach with two-way communication, where citizens are truly involved in a spontaneous manner. Through this structured approach, which collects citizens' opinions and uses questionnaires distributed on social networks, a bridge is created between the theoretical frameworks of participatory planning and their application in reality based on the concrete needs and demands of the community. Furthermore, in this research, participatory models are contextualized in light of the reality of urban development in Albania, providing two valuable case studies, that leave room for scientific discussions and further research on the urgency of citizen involvement in the process.

Furthermore, this research makes a methodological contribution by developing a framework with several layers, where citizen perceptions, expert assessments, geospatial data, etc. are combined, thus creating a valuable, transferable model that can support future research and empirical analyses on complex urban issues.

Practically, the results obtained provide valuable knowledge for experts in the field and decision-making institutions. The data analyses conducted in this research showed that ML and AI offer extraordinary potential in generating predictive models, especially for understanding reality through the citizen voices. Furthermore, the use of social media for data collection demonstrates their effectiveness as communication tools that institutions can use to understand community attitudes, identify urgent problems in time, establish priorities, and develop effective strategies for community engagement. Specifically, the analysis of the project's most critical issues, the identification of age groups most interested to engage in consultation processes, the identification of the most used social media by different age groups, and the identification of interrelated aspects in citizens' (and experts') perceptions provide concrete insights. These insights can serve as a practical instrument for decision-making bodies and urban planners.

Ultimately, the work carried out in this research contributes to building a comprehensive working model for digital urban governance in Tirana, where citizens are placed at the center of future urban development strategies. This contribution is not limited to the theoretical level but provides a practical framework based on NLP, demonstrating that ML and AI techniques offer the opportunity to systematically capture citizen perspectives in urban planning processes. By enabling a more democratic and transparent planning process, the proposed approach becomes very valuable in contexts like Albania, where participatory mechanisms are ineffective or symbolic.

7.5 Recommendations from the urban planning perspective

Based on the findings of this research, the following recommendations are proposed to support urban planners, decision-making institutions, and citizens in establishing a comprehensive and efficient communication system for urban planning issues in the city. Access is divided into several main categories:

- Decision-making institutions

  Decision-making institutions should establish comprehensive and real communication policies with citizens by institutionalizing mechanisms for systematically obtaining their opinions, starting from the preparatory stages of urban plans. This includes using social media to facilitate interactive communication with citizens, considering this channel a legitimate system that aims to address their real needs and demands. Standardizing this process would include concrete steps followed in collecting data, analyzing it, and documenting how it affected decision-making, significantly increasing transparency and trust in institutions.

- Urban planners

  By systematically using citizen data collected from social media, urban planners can identify the needs, demands, concerns, and priorities of the community in real time. The findings of this research demonstrated that analyzing spontaneous citizen data represents an effective way to avoid problems related to resistance to projects or urban issues, as well as to address various aspects of projects that the public has considered a priority. Their consideration, not just in the preparatory stages but throughout the entire project's duration, helps ensure that the project is compatible with the real community needs. In this context, urban planners must create a working practice where citizens' opinions play a well-defined key role.

- Citizens

  Citizens should be encouraged to be active participants in urban planning processes through well-thought-out strategies that influence their motivation. Creating such a vision requires, above all, a deep understanding of the real conditions of the community and their most urgent needs. By standardizing participation, it becomes possible to transparently show how their opinions are reflected in the decisions made and the projects designed, significantly increasing their trust in the institutions. These feedback mechanisms should be secure and consistent because only in this way can they become meaningful and valuable instruments to foster a sense of belonging and shared responsibility for a sustainable future.

7.6 Future research directions

The paradigm established in this research can provide a foundation for the expansion and enhancement of future research on participatory planning. Expansion of this work could focus on increasing the number of responses, especially on data collected by experts, to increase the analytical power of the results. Furthermore, various additional urban concerns can be examined within the same framework, albeit with different facets of the study, mostly concentrating on public perception and engagement. Incorporating additional dimensions from similar projects can uncover significant factors that could impact the final outcomes.

Enhancing the sampling enables the execution of intricate prediction analyses via the incorporation of sophisticated language models, such as the Large Language Model (LLM). The concept of an LLM represents an intriguing study that creates a model fed with citizen data, enabling it to predict citizen expectations for other projects currently in the planning phase. Such an implementation would bring a series of benefits for urban planners and decision-making institutions. Through such a system, the decision-making process would become easier and more legitimate against the needs and demands of the community.

In this context, it is important to mention that participation is a dynamic process, and it is possible that the perception of citizens and experts may change over time as the project phases advance. Therefore, this research repeatedly stresses the need for continuous monitoring of citizens' and experts' perceptions through a regular, institutionalized framework. In light of these considerations, since interactivity with institutions is a limitation of this research, future research could examine how the formal implementation of the proposed model might affect decision-making processes in urban planning once the institutions are under more stable institutional conditions.

7.7 Final word

In conclusion, despite the limitations of this research, it demonstrates the potential that ML and AI have to shape and improve participatory urban planning issues. Furthermore, the findings of this research showed that the success of implementing various urban projects does not only depend on the technical solutions of experts in the field, but also on the degree of citizen involvement in the planning of the city. The Tirana Riverside Project case study illustrates how data, technology (specifically ML and AI), social media, and inclusive processes combined together in a communication system can impact the increase in transparency and a sense of shared responsibility for the community. Ultimately, this work laid a foundation for transforming the urban planning process into a more comprehensive approach to building cities with higher social well-being and, above all, with sustainability at the forefront.

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