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SUSTAINABLE URBAN DEVELOPMENT AND UNIVERSAL DESIGN: A COMPARATIVE ANALYSIS OF THREE GREEK CITIES

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ABSTRACT

Universal Design has emerged as an increasingly important approach to the development of inclusive, accessible, and sustainable environments. Its significance extends beyond the provision of technical accessibility measures, as it addresses the ability of people with different physical, sensory, cognitive, and social characteristics to participate independently and equitably in everyday life. In the urban environment, this perspective is particularly important because streets, pavements, public transportation, squares, cultural sites, and public buildings form interconnected systems through which people move and interact.

This study investigates the relationship between Universal Design and sustainable urban development through a comparative analysis of three Greek cities: Larissa, Trikala, and Athens, within the framework of a study conducted based on questionnaires and interviews with responsible municipal officials. The research adopts a qualitative multiple-case-study methodology combining an extensive literature review, analysis of planning and municipal documentation, examination of urban interventions, and qualitative primary research based on semi-structured interviews with relevant municipal authorities. The three cities were selected because they demonstrate different approaches to accessibility, sustainable mobility, public-space transformation, and urban innovation.

The findings indicate that Universal Design is implemented differently according to the spatial, social, cultural, historical, and institutional characteristics of each city. Larissa demonstrates a transitional approach associated with the gradual modernization and adaptation of the existing urban fabric. Trikala represents a more integrated model in which accessibility is connected with sustainable mobility, smart-city initiatives, and urban innovation. Athens illustrates a cultural and pedestrian model in which accessibility and sustainable mobility intersect with the preservation and enhancement of the historic urban environment.

The study argues that the effectiveness of Universal Design cannot be evaluated exclusively through the existence of individual accessible elements. Rather, accessibility depends on the continuity of routes, the coherence of the urban environment, the quality and maintenance of infrastructure, the availability of sustainable mobility options, and the actual experience of sers.

Keywords: Universal Design; Accessibility; Sustainable Urban Development; Inclusive Design; Public Space; Sustainable Mobility; Greek Cities; Human-Centred Design; Urban Planning

1 INTRODUCTION

The contemporary city is increasingly understood as a complex environment in which environmental, social, economic, technological, and cultural dimensions interact. Urban development is no longer concerned exclusively with the construction of infrastructure or the physical expansion of settlements. It also involves the creation of environments in which people can move, communicate, work, rest, participate, and experience the city safely and independently [1].

This broader understanding of urban development has increased the importance of inclusive and human-centred approaches to design. Among these approaches, Universal Design occupies a particularly significant position because it proposes that environments should be conceived from the beginning to accommodate the greatest possible diversity of users.

Universal Design is closely associated with the recognition that human beings do not constitute a homogeneous group. People differ in age, physical ability, sensory perception, cognitive capacity, mobility patterns, cultural background, and everyday needs. Furthermore, people's abilities may change throughout their lives [2]. Temporary injury, pregnancy, ageing, illness, carrying children, or transporting objects can all affect how an individual interacts with the built environment. Consequently, accessibility should not be considered exclusively as an issue concerning people with permanent disabilities [3]. It should be understood as an essential dimension of the quality and functionality of the urban environment.

The United Nations Convention on the Rights of Persons with Disabilities reinforces this understanding by identifying accessibility as a fundamental condition for independent living and participation in society. Accessibility encompasses the physical environment, transportation, information and communication, and facilities and services open to the public [4]. Within this framework, Universal Design is understood as a means of creating products, environments, programmes, and services that can be used by people to the greatest extent possible without the need for specialized adaptation.

This conceptual shift has important implications for urban design. Instead of asking whether a particular building entrance contains a ramp, or whether a particular pavement satisfies a dimensional requirement, the designer and planner must consider whether the complete environment enables a person to reach a destination, understand the environment, move safely, rest when necessary, interact with others, and participate in urban life [5]. The distinction is therefore between an accessible element and an accessible environment. A technically correct ramp does not necessarily produce an accessible journey. If the pavement leading to it is blocked, if the pedestrian crossing cannot be used safely, if the public transport stop is inaccessible, or if the destination cannot be entered independently, the person continues to experience exclusion [6].

The present study approaches Universal Design from this broader perspective. It investigates how accessibility is incorporated into public space and how it interacts with sustainable mobility and wider urban-development strategies. The Greek context provides a particularly interesting field of study because Greek cities have developed through different historical, geographical, architectural, and institutional conditions [7]. Dense urban fabrics, historic centres, narrow streets, archaeological sites, extensive private vehicle use, irregular pedestrian infrastructure, and varying municipal capacities create significant challenges for the implementation of Universal Design. At the same time, several Greek cities have undertaken important initiatives aimed at improving pedestrian mobility, accessibility, sustainable transportation, public space, and digital urban services. Within this context, Larissa, Trikala, and Athens provide three particularly useful cases for comparative analysis [8].

The purpose of this research is not to establish which city is the most accessible. Rather, the objective is to investigate how different cities approach Universal Design and to identify the conditions that contribute to successful or unsuccessful implementation [9]. The central research question is therefore how Universal Design can contribute to sustainable urban development in Greek cities and how its effectiveness is influenced by urban form, planning strategies, institutional coordination, maintenance, mobility systems, and user experience [10].

2 UNIVERSAL DESIGN AND THE EVOLUTION OF INCLUSIVE DESIGN

Universal Design developed from the broader movement towards barrier-free environments and accessibility. Earlier approaches frequently focused on eliminating obstacles for particular groups, especially people with physical

disabilities. Although these interventions were important, they often resulted in adaptations added to environments that had originally been designed according to a narrower understanding of the user [11].

Universal Design introduced a different philosophy. Rather than designing for a presumed average user and subsequently modifying the environment for people who do not fit that model, it proposes that human diversity should be incorporated into the design process from the beginning [12].

The seven principles established by the Center for Universal Design provide an important conceptual foundation [13]. These principles concern equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, and appropriate size and space for approach and use. In the context of urban design, these principles can be interpreted in broader terms. Equitable use means that public spaces should be available to different groups without segregation or unnecessary specialization [14]. Flexibility means that spaces should accommodate different patterns of movement and use. Simplicity and perceptibility are particularly important in environments where people may experience cognitive or sensory difficulties. The principle of tolerance for error is also highly relevant to public space. Urban environments inevitably contain uncertainty and unexpected situations. A well-designed environment should reduce the consequences of mistakes and provide safe alternatives when users encounter obstacles or changes [15].

Low physical effort is important not only for wheelchair users but also for older people, people with temporary mobility difficulties, parents with children, and anyone who may experience fatigue. Universal Design therefore represents a transition from designing primarily for physical access to designing for overall usability. This distinction becomes increasingly significant as populations age. The demographic transformation occurring across many societies means that the number of people who experience mobility, sensory, or cognitive limitations is likely to increase [16]. An urban environment designed around diversity can therefore be understood as an investment in long-term social sustainability.

The useful and constructive role that digital technologies play in the realm of education for development must now be emphasized. To strengthen the field of entrepreneurial education, we must encourage the use of digital technology across economic and development educational areas. We have to be inspired and adopt paradigms from other educational domains like Mobile devices (57), a range of ICTs (58-61), AI & STEM ROBOTICS (62-65), and other technologies and paradigms that enable and enhance educational processes like evaluation, intervention, and instruction, which could be embraced and used in entrepreneurial education. Additionally, the use of ICTs in connection with theories and models of metacognition, mindfulness, and emotional intelligence development [66-69] speeds up and improves educational practices and results, especially for urban entrepreneurship and development.

3 UNIVERSAL DESIGN AND SUSTAINABLE URBAN DEVELOPMENT

The relationship between Universal Design and sustainability is sometimes overlooked because sustainability is frequently associated primarily with environmental issues. Sustainable urban development, however, has environmental, economic, and social dimensions [17]. A sustainable city should not only minimize environmental impacts. It should also provide opportunities for participation and access to resources for different groups within society. From this perspective, accessibility becomes a fundamental component of social sustainability.

A pedestrian environment that can be used comfortably by older people can simultaneously support parents with children and people carrying goods. Accessible public transportation can increase independence for people with disabilities while also encouraging sustainable mobility among the general population. A well-designed public square can facilitate social interaction, recreation, and cultural activity for a wide range of users [18]. Universal Design can therefore contribute to sustainability by reducing dependence on private vehicles, encouraging walking and public transport, supporting active ageing, and improving the overall quality of public space.

The connection between accessibility and sustainable mobility is particularly significant. If a pedestrian route is inaccessible, a person with a mobility limitation may be forced to rely on a private vehicle or assistance [19]. The absence of accessibility therefore has environmental as well as social consequences. Similarly, inaccessible public transportation limits the possibility of choosing more sustainable forms of mobility. The sustainable city and the inclusive city should consequently not be treated as separate objectives. A sustainable urban environment must be capable of supporting diverse users [20]. This relationship can be understood as a continuous process in which accessibility strengthens independent mobility, independent mobility increases participation, and participation contributes to social sustainability and quality of urban life.

4 RESEARCH METHODOLOGY

This study employs a qualitative multiple-case-study methodology designed to investigate the relationship between Universal Design, accessibility, and sustainable urban development within three different Greek urban contexts.

The methodology combines theoretical research with empirical investigation [21]. An extensive literature review was conducted to establish the conceptual framework concerning Universal Design, inclusive design, accessibility, sustainable development, sustainable mobility, and public-space design. International literature and institutional frameworks were examined to identify the principal concepts and criteria used in contemporary approaches to inclusive urban environments [22].

The literature review was complemented by the analysis of municipal and planning documentation relating to the three selected cities. Official information, planning strategies, descriptions of urban interventions, accessibility initiatives, sustainable mobility measures, and relevant public-space projects were examined to understand the institutional and spatial context of each case. Primary qualitative research was also conducted through semi-structured interviews with relevant municipal authorities [23]. The interviews focused on the practical implementation of accessibility strategies, the relationship between accessibility and urban planning, the difficulties encountered during implementation, the management and maintenance of public infrastructure, and the extent to which Universal Design is incorporated into municipal strategies [24]

The use of semi-structured interviews allowed a common set of issues to be investigated across the cases while providing sufficient flexibility for participants to discuss specific challenges and local conditions. The research does not attempt to establish a statistical measurement of accessibility. Instead, it seeks to understand the different approaches through which accessibility and Universal Design are incorporated into urban environments [25].

The three cities were selected because they provide contrasting urban contexts. Larissa represents a medium-sized Greek city undergoing gradual transformation of its urban environment. Trikala provides an example of a city that has combined accessibility with sustainable mobility and smart-city development. Athens, as the capital and largest metropolitan area, provides a more complex case in which accessibility interacts with historic urban fabric, cultural heritage, pedestrianization, tourism, and high levels of urban activity [26]. The comparative framework focused on accessibility, continuity of pedestrian movement, sustainable mobility, social inclusion, functionality, user experience, and the long-term management of public space. This approach makes it possible to move beyond a simple description of infrastructure and to examine the broader relationship between design, planning, implementation, and use [27].

5 LARISSA: A TRANSITIONAL MODEL OF URBAN MODERNIZATION

Larissa provides an important example of the gradual transformation of an existing Greek urban environment. The city has introduced interventions aimed at improving accessibility, pedestrian movement, public infrastructure, and sustainable urban development. The importance of these interventions lies not only in the individual improvements but also in the attempt to integrate accessibility into broader municipal planning [28].

The Larissa case illustrates the complexity of adapting an existing urban fabric.

Urban environments are rarely designed as complete systems from the beginning. They develop incrementally over many decades. Streets, pavements, buildings, parking arrangements, public spaces, and transportation infrastructure are constructed and modified at different times according to different standards and priorities [29].

As a result, achieving continuous accessibility can be considerably more difficult than designing accessibility into a new development. In Larissa, improvements in accessibility coexist with challenges associated with the continuity of pedestrian routes and the management of public space. Physical obstacles, discontinuities, parking practices, surface conditions, and differences between individual interventions can influence the overall user experience [30].

The significance of the Larissa case is therefore not that accessibility is absent, but that it is part of an ongoing process of transformation. The city can be characterized as a transitional model of urban modernization, in which accessibility is increasingly recognized as an important planning objective while the complete integration of Universal Design throughout the urban fabric remains a continuing challenge [31]. This transitional character is particularly valuable for understanding Greek cities because many municipalities face similar conditions. Existing urban environments cannot simply be replaced. They must be gradually adapted while remaining functional for everyday life. Universal Design in this context becomes a process of continuous improvement [32].

6 TRIKALA: AN INTEGRATED MODEL OF A SMART AND ACCESSIBLE CITY

Trikala provides a different perspective on the relationship between Universal Design and urban development. The city has developed a strong profile in relation to innovation, digital technologies, sustainable mobility, and smart-city initiatives. This provides an environment in which accessibility can be considered as part of a broader transformation of urban systems.

The Trikala approach is particularly significant because accessibility is not treated exclusively as a specialized intervention for people with disabilities. Instead, it can be connected to pedestrian movement, cycling, transportation, digital information, and public-space development. This integration creates the possibility of combining physical and digital forms of accessibility [33]. The physical environment remains fundamental. Accessible pavements, ramps, pedestrian routes, crossings, and tactile guidance are necessary conditions for independent movement. However, digital technologies can complement physical accessibility by providing information, navigation assistance, transport information, and communication services. This relationship is particularly relevant to the concept of the smart city [34]. A smart city should not be understood solely as a technologically advanced city. Its intelligence should also be measured by its capacity to respond to the needs of its inhabitants [35]. Technology becomes meaningful when it improves people's ability to participate in urban life.

Nevertheless, the Trikala case also demonstrates an important limitation: digital innovation cannot compensate for inaccessible physical infrastructure. A person cannot benefit from an excellent digital navigation system if the pavement remains physically blocked. The physical and digital environments must therefore operate together [36]. Trikala can consequently be interpreted as an integrated model of a smart and accessible city, where Universal Design is increasingly associated with sustainable mobility, technological innovation, and broader urban transformation.

7 ATHENS: UNIVERSAL DESIGN, CULTURAL HERITAGE AND THE URBAN PROMENADE

Athens presents a substantially different challenge. The historic centre contains archaeological sites, historic buildings, dense urban development, major transportation infrastructure, tourist activity, commercial uses, and large numbers of pedestrians. The Unification of the Archaeological Sites represents one of the most significant transformations of the historic centre, creating pedestrian connections between important cultural and archaeological locations [37].

This transformation illustrates the relationship between pedestrian mobility, cultural heritage, public-space quality, and accessibility. The pedestrian route is not simply infrastructure for movement. It becomes an environment in which people can walk, stop, observe, rest, communicate, and experience the city. The intervention therefore demonstrates that Universal Design can have a cultural dimension. Accessibility can contribute to making cultural heritage more available to a broader population. At the same time, Athens demonstrates the difficulties associated with accessibility in historic environments [38].

Archaeological surfaces, historic materials, narrow streets, changes in level, existing buildings, and competing transportation requirements can make comprehensive accessibility difficult. The challenge is consequently to find an appropriate balance between the protection of cultural heritage and the contemporary requirement for inclusive access. The Athens case demonstrates that Universal Design does not necessarily mean eliminating the historical character of a place. Instead, it requires designers and planners to search for ways of improving accessibility while respecting the identity and cultural significance of the environment [39]. Athens can therefore be characterized as a cultural model of Universal Design and urban promenade.

8 COMPARATIVE DISCUSSION

The comparison of the three cities demonstrates that Universal Design is strongly influenced by context. Larissa, Trikala, and Athens do not face identical problems, and consequently they do not require identical solutions [40].

Larissa demonstrates the challenges of adapting an existing urban fabric. Its experience highlights the importance of gradual modernization, continuity, and maintenance. Trikala demonstrates the potential of integrating accessibility with sustainable mobility, technological innovation, and smart-city strategies. Athens demonstrates how accessibility can be connected with pedestrianization, cultural heritage, and the transformation of the historic centre [41].

The three approaches can therefore be understood as different expressions of the same underlying principle: the city should be designed and managed according to the diversity of its users. One of the strongest findings of the comparison concerns the importance of continuity. An accessible pavement that ends abruptly does not create an accessible route

[42]. A tactile path that is interrupted by an obstacle does not provide continuous guidance. An accessible public transport stop that cannot be reached safely does not provide independent mobility.

This finding suggests that the fundamental unit of accessibility should not be the individual infrastructure element but the complete journey [43]. This is particularly important for municipal planning. When an accessibility project is evaluated, attention should be given not only to whether individual technical requirements have been fulfilled but also to how the intervention connects with surrounding infrastructure. The quality of the route should be evaluated from the user's perspective.

9 FROM COMPLIANCE TO INCLUSION

The research also demonstrates the importance of distinguishing between regulatory compliance and genuine inclusion. Technical regulations provide essential minimum requirements. Without standards, accessibility can become inconsistent and difficult to enforce [44]. However, compliance alone cannot guarantee an inclusive environment. A technically compliant pavement can still be uncomfortable. A correctly dimensioned ramp can still be inaccessible if it is blocked. An accessible parking space can become unusable if it is occupied illegally. A tactile guidance route can lose its function when it is interrupted.

The effectiveness of Universal Design therefore depends on what happens after construction. Design must be accompanied by appropriate management, maintenance, monitoring, and enforcement [45]. This observation is particularly relevant to the Greek context because the quality of public space is often affected by everyday practices. Illegal parking, temporary obstacles, commercial activity, poor maintenance, and uncontrolled use can transform an originally accessible intervention into an inaccessible environment. Universal Design should therefore be considered a continuous process rather than a completed project.

10 UNIVERSAL DESIGN AS A STRATEGY FOR GREEK CITIES

The three case studies suggest that Greece does not necessarily require one standardized urban model. Instead, Universal Design should provide a common framework that can be adapted to the particular characteristics of each city. Greek cities present considerable diversity [46]. Historic centres, modern residential areas, coastal environments, dense metropolitan districts, smaller urban centres, archaeological sites, tourist destinations, and suburban areas present different challenges.

The implementation of Universal Design must therefore respond to local conditions while maintaining fundamental principles of equality, accessibility, safety, and independence [47]. A successful strategy should integrate accessibility into the earliest stages of urban planning rather than treating it as a subsequent correction.

This means that accessibility should be considered when pedestrian networks are planned, when public transportation is reorganized, when public spaces are redesigned, when cultural sites are interpreted, and when new digital services are developed [48]. It should also be incorporated into the long-term management of public space. The design process does not end when construction is completed. Monitoring and maintenance are essential to preserving accessibility over time. Another important conclusion concerns the need for interdisciplinary and participatory approaches.

Urban accessibility cannot be addressed effectively by a single professional discipline.

Architects and designers contribute knowledge concerning spatial organization and human experience. Engineers contribute technical expertise. Urban planners examine networks and mobility [49]. Municipal authorities provide institutional knowledge. Disability organizations and users contribute direct experiential knowledge. The relationship between these groups should therefore become collaborative. Instead of a linear relationship in which the designer produces an environment for a passive user, the process should involve continuous interaction between designers, users, professionals, caregivers, authorities, and communities [50]. This is particularly important because users often identify problems that are not immediately visible through technical analysis.

Limitations of the Study

The study has several limitations that should be acknowledged. First, the research focuses on three Greek cities and therefore does not claim to represent the entire Greek urban environment. The selected cases provide useful comparative examples, but other cities may demonstrate different approaches and challenges. Second, the qualitative nature of the research means that the findings are primarily interpretive rather than statistically generalizable [51]. The interviews provide valuable professional and institutional perspectives, but they do not constitute a representative

survey of all stakeholders. Third, the research would benefit from more extensive direct participation by users of different abilities. Although the study examines accessibility from a human-centred perspective, future research should place greater emphasis on the direct experiences of wheelchair users, people with visual and hearing impairments, older people, people with cognitive disabilities, caregivers, and other users who experience barriers in the built environment [52].

Finally, accessibility is a dynamic condition. Urban infrastructure, municipal policies, maintenance practices, and mobility systems change over time. The findings should therefore be understood as a contextual analysis rather than as a permanent evaluation of the three cities.

11 CONCLUSIONS

This study examined the relationship between Universal Design and sustainable urban development through a comparative analysis of Larissa, Trikala, and Athens. The research demonstrates that Universal Design should be understood as a comprehensive approach to urban development rather than simply as a technical response to disability [53]. Its purpose is to create environments that support participation, independence, safety, comfort, and dignity for the widest possible range of users.

The three Greek cities examined in this research demonstrate different approaches.

- -Larissa illustrates the challenges of gradually adapting an established urban environment and can be understood as a transitional model of urban modernization.
- -Trikala demonstrates the potential of integrating accessibility with sustainable mobility, smart-city technologies, and urban innovation and can therefore be interpreted as an integrated model of a smart and accessible city.
- -Athens demonstrates how accessibility can be connected with pedestrianization, cultural heritage, and the transformation of the historic urban environment, creating a cultural model of Universal Design and urban promenade.

Despite their differences, the three cases lead to a common conclusion: the effectiveness of accessibility depends on continuity. The city is experienced as a connected environment [54]. Users do not move from one accessible element to another in isolation. They experience complete journeys. For this reason, Universal Design must move beyond individual interventions and address the continuity of the entire urban system. This requires collaboration between planning, architecture, engineering, transportation, technology, municipal administration, and users. It also requires a transition from a compliance-based approach to a human-centred understanding of inclusion [55]. A sustainable city cannot be genuinely sustainable if parts of its population cannot participate in urban life. Accessibility is therefore not an additional characteristic of sustainable development. It is one of its fundamental social dimensions.

The study ultimately proposes that Universal Design should be incorporated into Greek urban planning as a long-term strategic framework connecting accessibility, sustainable mobility, social inclusion, cultural heritage, public-space quality, and human experience. The future of inclusive Greek cities will depend not simply on how many accessible interventions are constructed, but on whether these interventions form coherent systems that people can actually use [56]. Universal Design should therefore become an integral part of how cities are conceived, designed, implemented, maintained, and continuously adapted to the people who inhabit them. Overall, as a comparative assessment, the three cases represent different levels of maturity in the implementation of universal design:

Larissa is at a transitional stage, showing significant progress but still facing issues related to continuity and implementation. Trikala represents a more mature and coherent model, in which universal design, sustainable mobility, and the smart city concept operate as an integrated system. Athens presents a distinctive model of cultural universal design, where accessibility is combined with the promotion of cultural heritage and the creation of a public promenade of international significance [57].

The overall comparison shows that universal design in Greece does not follow a single model of implementation but varies according to the urban context. In medium-sized cities (Larissa, Trikala), the focus is primarily on sustainable mobility and functional urban upgrading, whereas in the case of Athens, universal design acquires a cultural and symbolic dimension. Thus, three different models emerge: Larissa: a transitional model of urban modernization. Trikala: an integrated model of a smart and accessible city [58]. Athens: a cultural model of universal design and urban promenade. In all three cases, the common denominator remains the effort to transition towards more inclusive, sustainable, and accessible cities, where public space is redefined as a space of equality, experience, and social coexistence.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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The Authors proclaim no conflict of interest.

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