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Metamorphosis through Transition

The application of TOD as mobility / land-use model, and its applicability in the case of Tirana

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Cycle XXXIII

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International Doctorate in Architecture and Urban Planning

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Università degli Studi di Ferrara | DA Dipartimento Architettura Ferrara

UNIVERSITETI POLIS

INTERNATIONAL DOCTORATE
IN ARCHITECTURE AND URBAN PLANNING

Cycle XXXIII

IDAUP Coordinator Prof. Roberto di Giulio

"Metamorphosis through Transition"

The application of TOD as mobility / land-use model, and its applicability in the case of Tirana

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ABSTRACT

The primary focus of this research is on "Transit Oriented Development as a growth paradigm in an attempt to become a catalyst in influencing city development . Transit-Oriented Development (TOD) has developed as a feasible model for integrating transportation and land use in both mature and rapidly growing cities around the world . Is the emphasis on sustainable urban transportation a more tightly defined definition of sustainable transportation, or is the emphasis on transportation sustainability more broadly defined? Due to the impossibility of reaching a scientific consensus on what defines a truly sustainable transportation system, it is necessary to compile a complete list of all the definitions and characteristics that exist. It is important to identify the major aspects and components of TOD models by constructing a foundation and providing an alternative to the single standard model of planning that is currently used in growing cities such as Tirana, given that TOD is a concept that has been extensively researched. Tirana, the capital of Albania, is now confronted with tough issues as a result of a whole regime of transition and internal migration that began in the late 1990s and has continued to this day. Transit Oriented Development can be viewed as the primary model for promoting, guiding, and developing through transportation and land use in this setting. This research will provide an overview of legislation, land use changes, and economic concepts, which will be integrated with the goals of Transit Oriented Development to provide a roadmap for long-term urban growth. This study is based on the hypothesis that developing a model for implementing Transit Oriented Development in Tirana will guide future development while reducing urban sprawl .

Keywords: Transit Oriented Development, catalyst development, land-use development, sustainability, Model, urban Growth, resilience, Model builder, urban sprawl

ABSTRACT(ITA)

L'indagine sullo sviluppo orientato al transito come paradigma di crescita nel tentativo di diventare un catalizzatore nell'influenzare lo sviluppo della città è l'enfasi principale di questa ricerca. In tutto il mondo, il Transit-Oriented Development (TOD) è emerso come una strategia praticabile per integrare i trasporti con l'uso del territorio sia nelle città mature che in quelle in rapida espansione. L'enfasi sul trasporto urbano sostenibile è una definizione più strettamente definita di trasporto sostenibile o l'enfasi sulla sostenibilità dei trasporti è definita in modo più ampio? A causa dell'impossibilità di raggiungere un consenso scientifico su ciò che definisce un sistema di trasporto veramente sostenibile, è necessario compilare un elenco completo di tutte le definizioni e caratteristiche esistenti. È importante identificare gli aspetti e le componenti principali dei modelli TOD costruendo una base e fornendo un'alternativa al modello unico standard di pianificazione attualmente utilizzato in città in crescita come Tirana, dato che TOD è un concetto che è stato ampiamente studiato . Tirana, la capitale dell'Albania, si trova ora ad affrontare problemi difficili a causa di un intero regime di transizione e migrazione interna iniziato alla fine degli anni '90 e continuato fino ad oggi. In questo contesto, lo "Sviluppo orientato al transito" può essere visto come il modello centrale per promuovere, guidare e sviluppare attraverso i trasporti e l'uso del territorio. Questo studio includerà una panoramica sulle politiche, sui cambiamenti nell'uso del suolo e sui principi economici che, combinati con gli obiettivi dello "Sviluppo orientato al transito", forniranno una linea guida sulla crescita urbana sostenibile. Questa ricerca si svolge partendo dal presupposto che la creazione di un modello per l'attuazione dello sviluppo orientato al transito nel caso di Tirana guiderà lo sviluppo futuro senza aumentare lo sprawl urbano.

Parole chiave: sviluppo orientato al transito, sviluppo catalizzatore, sviluppo dell'uso del suolo, sostenibilità, modello, crescita urbana, resilienza, costruttore di modelli, espansione urbana

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CONTENT

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

TOD	Transit Oriented Development
SD	Sustainable Development
GIS	Geographic Informational Systems
SUD	Sustainable Urban Development
SMCA	Spatial Multi Criteria Analysis
IMM	Integrated Modification Methodology
USAID	The United States Agency for International Development

1 CHAPTER ONE | A SIMPLE INTRODUCTION

1.1 Background

The complexity of addressing Transit Oriented Development as a theoretical notion and then as a development model demands consideration of both transportation planning and policymaking. Due to the complexity of implementing Transit Oriented Development as a theoretical theory and then as a development model, special attention must be paid to transportation planning and policymaking. For the purpose of dealing with the theoretical dimensions, components, and applications of transit-oriented development, a multidisciplinary approach is required that includes complementary disciplines such as urban development, history, transportation planning and the cognitive process of decision-making. The purpose of this study is to conduct an in-depth review of the literature on the concept of TOD, its application, and the way definitions and case studies present the components of TOD as a means of transforming this theory from a concept to an urban development model that influences contemporary transportation .It is expected that the first part of this research will help to theory formation and evolution of the idea through a review of relevant literature, comparison models, and the identification of common components (principles).

This research will make extensive use of Geographic Information Systems to construct a framework for the development of Tirana through the collection of data from orthophotos, mapping materials from previous studies, reports and various publications with the goal of measuring some of the physical components of development for the territory. An important part of this research will be the use of Geographic Information Systems to construct a framework for the development of Tirana. The last section will try to design a toolbox for implementation as well as the optimum development scenario for this model in developing nations, based on the findings of the research and case studies conducted so far. This research intends to

contribute to diversification of a modern classic urban planning approach of TOD. With the implementation of this concept, it is hoped that the future growth of the transportation planning would be enhanced. The thesis concludes with the creation of a model in GIS, which allows for the components to be measured, adapted and fitted into different urban context. As a concept, Transit Oriented Development was born out of a series of failed attempts to rejuvenate urban regions, as evidenced in our case studies . As previously said, there is no "recipe" to follow in order to be successful. The evolution occurred in the adaptation of this notion to distinct situations of development while taking the unique environment into consideration. In the book Life and Death of Great American Cities by Jane Jacobs (Jacobs, 1961) and Ebenezer Howard's" Garden Cities of Tomorrow (Ebenezer Howard, 1902) both highlight the components of this paradigm, which must be recognized as such when they are being translated and updated in future applications. This notion has been partially or completely realized, but the creation of a toolkit that is tailored to the individual has made all the difference. TOD is considered as a step forward from the past as a neo-traditional guide to sustainable community design and transportation .

1.2 Research Hypothesis

The purpose of this research is to examine "Transit Oriented Development" as a paradigm with the objective of discovering the variables and indicators that influence city development.

The process of constructing a basis and developing a non-standard application technique for Transit Oriented development is intrinsically related to the theory's deconstruction. A TOD is frequently distinguishable from conventional developments by its unique development characteristics, which include superior transit service, pedestrian and bicycle infrastructure, increased density, moderated private automobile infrastructure, and improved access to and diversity of land uses. The concept of Transit oriented development and its components constantly find their way into plans we would mention here Vienna "step Plan 2030" (Vienna, 2014) and Barcelona "Superblocks" (Commission for Ecology, 2016).

The scope of this research will focus on understanding the components of the theory by case study analyses and using these findings (or components) to measure the possibility of TOD application. The importance of TOD is present in new planning attempts and "newly" introduced concepts as well, we could mention here the 15 min cities a concept by Carlos Moreno, which embraces the same components as the concepts of Transit Oriented Development, promoting wellbeing in a bottom-up way (Pozoukidou G, 2021).

The focus on transport is not something new for cities, however the combination of components such as density, diversity, design in the case of TOD is giving a renascence to this concept. But with an abundance of plans pursuing sustainable development were does TOD prevail?

The following research questions are formulated and should be answered to complete this research:

Our two primary research questions and their associated sub questions:

Research Question 1:

- What is the link between TOD and Mobility?

Research Question 2:

- How the criteria and indicators for TOD are reflected into planning practices in both Europe and US context?

Research Question 3:

- How do TOD Indicators influence the urban transit Planning process and influence the urban environment?

Research Question 4:

- Can these criteria and indicators be integrated into unified model in GIS?

1.3 Objectives

Due to the complexity of this topic, it requires both transportation planning and policymaking attention. An interdisciplinary strategy that incorporates complementary disciplines such as urban development, history, transportation planning, and decision-making cognition. This section will contribute to the theory's growth and evolution through a survey of the literature, comparative models, and an emphasis on common components (principles). A significant component of this research will be the use of Geographic Information Systems to develop a framework for Tirana's development through the collection of data from orthophotos, mapping materials from previous studies, reports, and various publications aimed at quantifying various physical and theoretical (policies) components of the territory. The last section will seek to construct an application toolbox and the optimal development scenario for this model in developing nations, based on analysis and case studies. This is to allow for future urban planning and transportation growth using this measurement method. Acquire a thorough understanding of the idea of TOD and the different facets associated with it by amassing deep knowledge of TOD components. During the course of this research the objectives are clear and defined as:

- Build up an understanding of the concept of TOD though theoretical review of TOD Components.
- Exploring “Transit Oriented development” as a model, in an attempt to become a catalyst in influencing cities development .
- Help determine Urban transformations that require to develop a TOD
- Evaluating the transportation consequences of TODs through case studies and comparing the findings to those of traditional development in similar locations within the urban fabric.

1.4 Scope of the Research

This project will examine "Transit Oriented Development" as a paradigm, with the goal of being a catalyst for city development . "Transit-oriented development (TOD) is a viable paradigm for integrating transportation and land use in a growing number

of developed and emerging cities worldwide . The significance of this research is in defining the important traits and regulations for "rapidly rising cities" through the establishment of a foundation and the development of a non-standard planning model for developing cities such as Tirana . Albania's capital, Tirana, is currently facing enormous challenges as a result of a profound regime shift and internal migration that began in the late 1990s . From this vantage point, "Transit-Oriented Development" can be considered as the fundamental paradigm for promoting, guiding, and developing through transportation . This research will provide an overview of policies, land-use modifications, and economic concepts that, when combined with the goals of "Transit-oriented development," will result in an improvement in policies fostering sustainable urban growth . This investigation is based on the premise that building a model for transit-oriented development in Tirana will boost the city's competitiveness, guide feature development, and prevent sprawl.

1.5 The motivation behind this research

Transit-Oriented Development (TOD) as a technique for constructing sustainable communities has become increasingly prominent in urban development . The notion is enjoying a renaissance, as planners and cities attempt to incorporate TOD concepts into their plans and aims (Curtis, 2009).

This process is illustrated by the presence of TOD development concepts in planning practices. Keeping in mind that the concept of applicability is intrinsically tied to the sustainable development of cities, their inherent complexity, and the need for more context-sensitive planning approaches.

The use of TOD as a catalyst is contingent upon its application finding benefit and resulting in innovations, reforms, and a shift in planning strategy.

The inclusion of TOD development principles in planning techniques exemplifies this process. Keeping in mind that applicability is inextricably linked to the sustainable development of cities, their inherent complexity, and the requirement for more context-sensitive planning techniques.

TOD's employment as a catalyst is conditional on its implementation demonstrating value and resulting in innovations, reforms, and a shift in planning approach.

1.6 Thesis outline

Each chapter is divided into smaller sections that slowly contribute to the unraveling of the Topic, at the end of each section creating a bridge over the next theoretical discussion will be some conclusions and lessons learned from the previous sections.

The overall organization is reflected into the **first chapter** where the objectives, introductions and research problematics are introduced.

The second chapter is focused into the literature exploration of the main concepts of this topic, starting from cities and the challenges they face, how and why these challenges should be addressed.

The third Chapter is dedicated to complexity of the urban context and how we understand complexity in planning.

The fourth chapter explores the birth and evolving into deep exploration of the concept of TOD.

The fifth chapter is a road map into the selected methodological approach used to explore the concept of TOD in relation to its application context and future possible adaptation.

The Sixth chapter will consider the case studies as a benchmark into the contextual understanding of TOD. This chapter will categorize and define the data collection process, indirect data and GIS instruments that will provide the basis of critical comparative data.

The seventh chapter will draw focus into the case studies of Tirana and provide an understanding of the selective context.

The eighth Chapter will focus on the Comparative data conclusion and findings defining the impact of such findings into the overall objective of this research, the conclusions and overall conclusions will provide the findings of the research but also gap and continuity of this research in the future.

The Nineth and ten chapter will focus into the common findings and provide a clear view on our research data, bibliography and literature considered during this research.

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2 SECOND CHAPTER | THE URBAN DILEMA

2.1 The Urban Challenge

"***The world breaks everyone, some get stronger at the broken place***" (Hemingway, 1995).

The city is there; it already exists in an over changing context. Development models have a multidimensional meaning, defining city models or cities is no easy task. The Webster's dictionary defines cities as a complex relation between socio-economic relationships within a space and time.

One of the corner stones of cities radical change was the Neolithic revolution with the division of labor, much like the industrial revolution that starts in the industrial city, with incompatible uses and high complexity. These cities called for the deep understanding of its problems in order to be planned. In the post-industrial world however, the reconfiguration of space, economy and place is radically changed by only random movement of people. Michael Storper (2013) argues that cities must be treated more than an "urban playground for only a few1" but as a living workshop for cultivation talent, culture, creativity and sociability for people. (Storper, 2013)

According to Le Gates and Stout (1996), city life and growth bolster the city's complex systems, economics, and social environment.

The fact that cities are multifaceted and complicated is a common denominator, making identifying the difficulty that cities confront difficult. While cities as a physical entity encompass only 2% of the earth's area, they are home to 60% of the world's

1 For Planners to test theories and policy, applicability: https://doi.org/10.11120/jebe.2009.04020029

inhabitants . This figure is expected to rise to 65% by 2030[2] . Massive urbanization is a global phenomenon, resulting in increased land consumption, sprawl, pollution, economic and social inequality, transportation congestion, and city footprint development[3] (Habitat, 2020). Cities are dealing with these challenges on a daily basis, interdisciplinary studies work continuously to find solutions and to mitigate these challenges. Cities all over the world are trying to implement planning solutions that help and guide cities to turn problems into opportunities (Barrionuevo, 2012).

The Eco-City is a concept born during the 60's mid and 70's. This concept was born as controversy of the deterioration of natural resources. Richard Register first coined the term in 1975' in his book *"Eco Cities: Rebuilding Cities in Balance with Nature".* As a positive approach into understanding and meeting cities challenges, eco-cities take us on a journey to the future city, where development occurs within the means of our environment[4] In the book the city is treated like an organism and should be built as such. Many eco-cities have the overall goal of removing emissions, generating electricity exclusively from green sources and incorporating the nature into the city; however, eco-cities are also designed to promote economic growth, minimize poverty, structure cities with higher population densities, higher productivity, and enhance health. Transport and development are an essential part of this theory with a focus of developing for people, with high density and walkable centers, the theory enhances the reversing of the role transport plays in the city. The challenge in building dense, vibrant, green, secure, friendly and essential mixed-use communities near transit nodes and other transport services, by revising land-use goals. Based on design principles that use transportation and mobility to increase accessibility. The concept sees resources, ecological linkage, culture, quality of life as an essential part of urban economy, bringing together the evolving city and natural capacities. (Register, 2006) Some of the design principles with a

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[2] *UN Habitat World Cities Report 2020, prediction.*

[3] *Simin Davoud also highlighted these challenges during the 2017 Helsinki AESOP conference.*

[4] *Talking about the elephant in the room: Climate change, sprawl, transportation, food ect./* "Eco Cities: Rebuilding Cities in Balance with Nature" (1975). Xxxx make it correct

focus on transport, brought forwards by Richard Register in his books are illustrated below.

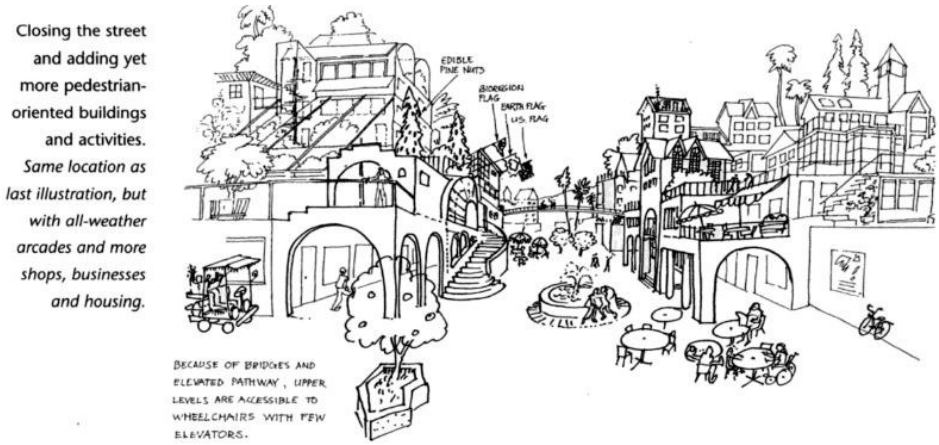


Figure 1 Register, R. (2006). Eco Cities: Rebuilding Cities in Balance with Nature (Revised Edition). New Society Publishing (Page 23)

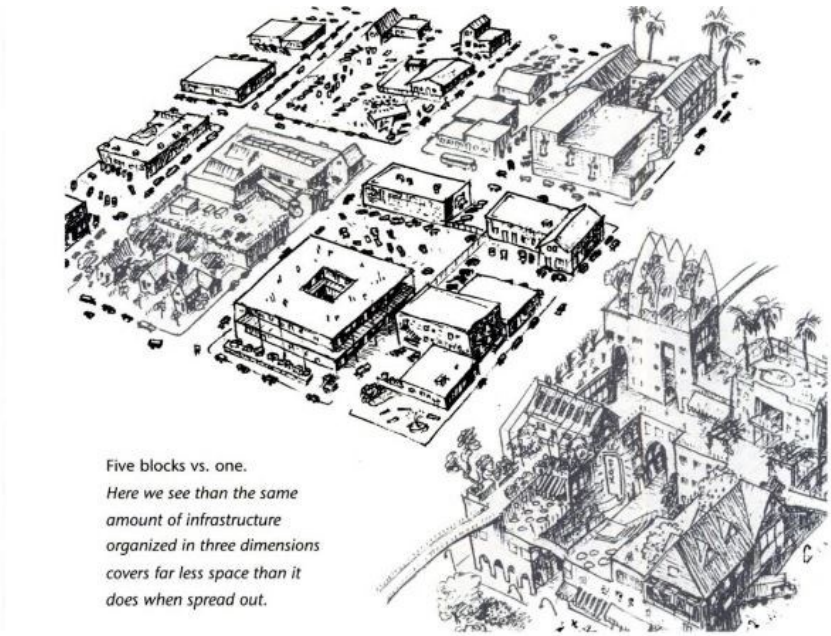


Figure 2 Register, R. (2006). Eco Cities: Rebuilding Cities in Balance with Nature (Revised Edition). New Society Publishing (Page 77)

Smart Cities was a term that made an appearance in the 1990's, the term itself is not at all new, starting as movement that advocated new policies in cooperation with technological advancement, inter-connectivity, safe and attractive urban development. The concept is derived from the smart growth movement in the early 90's (Bollier, 1998).The concept has since evolved into any technology-based approach to planning or development (Bakıcı, 2013). It offers the possibility to utilize

technological advancement into the planning process and to improve management and decision-making. Cities' metabolisms are often characterized by the entry of products and the outflow of debris, both of which have constant negative externalities that exacerbate social and economic difficulties. Cities rely on an inordinate amount of external resources and are, in fact, resource consumers (and will likely always be) . The term "smart city" is widely understood ideologically in the context of urban planning, with smarter signifying strategic orientations.

Governments and international organizations at all levels are embracing the concept of smartness to differentiate their policies and programs aimed at promoting sustainable development, economic growth, enhancing citizens' quality of life, and promoting happiness (Chen, 2010).

The smart city prioritizes sustainability, quality of life, urbanization, and smartness spatially . "A city is smart when investments in human and social capital, as well as traditional (transport) and modern (ICT) communication infrastructure, support long-term economic growth and a high standard of living, while also promoting responsible resource management through participatory governance" (Caragliu, 2011).

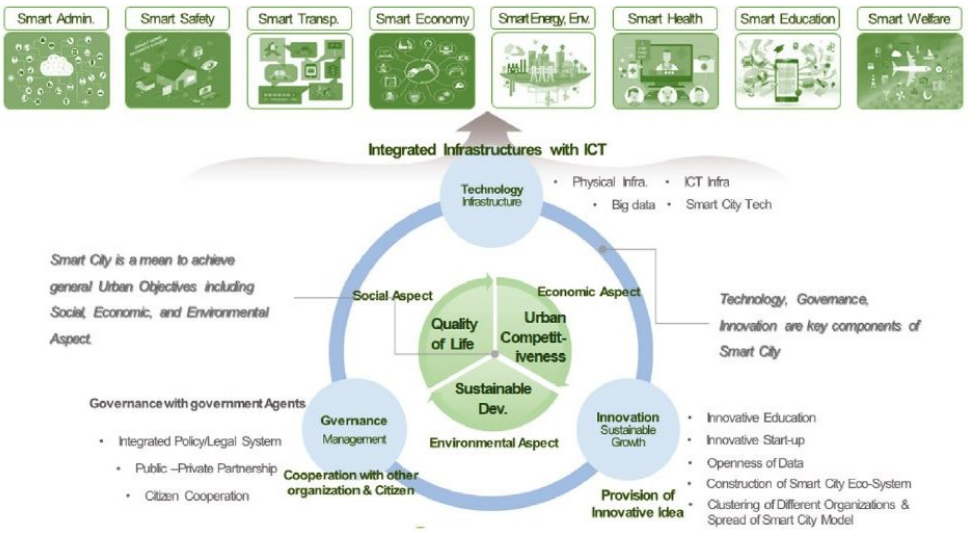


Figure 3 The smart city concept / (Lee, J. Y. (2018). Catalyzing the evolution of ICT based growth ecosystems in cities.

The phrase "Resilient Cities" is a relatively recent addition to the lexicon of urbanism . The term "resilience" in the context of cities refers to an urban system's capacity to absorb, adapt to, and respond to change . However, this article asserts

that resilience shares significant similarities with other essential contemporary urban goals, such as sustainability (K. C. Desouza, 2013). The term speaks of a hidden opportunity for cities, to revive and reduce their vulnerability. Resilient cities can be applied to respond to crises, adapt and change for the future. As we explore the core of resilience, the quicker the system returns to its natural state the greater the resilience of this system (K. C. Desouza, 2013). However, resilience is mostly used in ecology to describe the level of disturbance a system can endure before its changes structure. (V. Raj Sharma, 2019). As a system-based, complex, and dynamic process, resilience offers the required context for understanding the risk and vulnerability that this system faces. “Resilient cities” have gained popularity as a way to encourage communities to reduce their risk and prepare for natural, anthropogenic, and economic catastrophes.
“Although cities have been destroyed throughout history—sacked, shaken, burned, bombed, flooded, starved, irradiated, and poisoned—they have, in almost every case, risen again like the mythic phoenix.” (Vale, 2005)

Resilience is a rather old concept; in the 17th century, Samuel Grot used the term to refer to physical counter-reactions and reversion to their earlier state. "Resilience," according to Robert Greene, was the balance of forces operating on a body as push forces for expansion. (R.Greene, 1727) Crawford Stanley Holling pioneered the notion of population balance by transferring it from physics, applied mechanics, psychology, and ecology, so establishing the first separation between resilience in other fields and ecology. In his work Ecological Systems' Resilience and Stability (Holling, 1973).

As a transferable notion for dealing with dynamic models, the concept rapidly found its way into urban planning (S. Gößling-Reisemann, 2018). Sir Michael Pitt's Learning Lessons from the 2007 Floods" is one of the most frequently used definitions of resilience in planning: adaptation and recovery in the face of catastrophe. Sir Michael Pitt conducted an independent review in 2007, (Pitt, 2007). Finally, Simin Davoudi views resilience as a cycle leading to emergence, throughout the system's development and stabilization, whereas attaining

rigidification and decline opens the way to "creative destruction" or rather unanticipated alternatives (Davoudi, 2012, pp. 299–333).

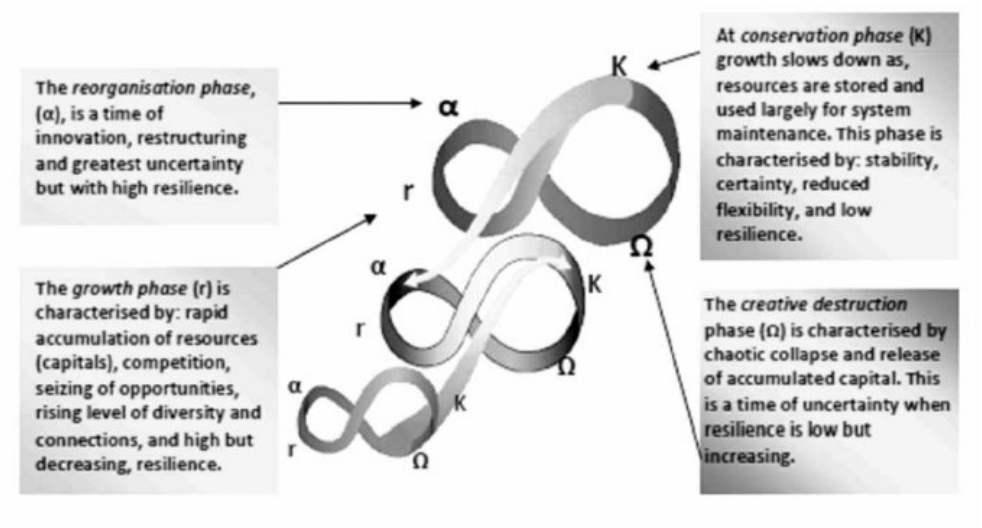


Figure 4 The panarchy model of adaptive cycle. Source: Davoudi, et al adapted from Holling and Gunderson (2002, pp. 34–41) and Pendall et al (2010, p. 76) .

Despite of the Crawford Stanley Holling (Holling, 1973), Michael Pitt, (Pitt, 2007) and Simin Davoudi, (Davoudi, 2012) definitions, this concept is yet to be defined by what resilience really means, or how it is expected to be translated into cities. However, for the purpose of this study we are going to focus on some similar characteristics of these urban challenges mitigating models of development.

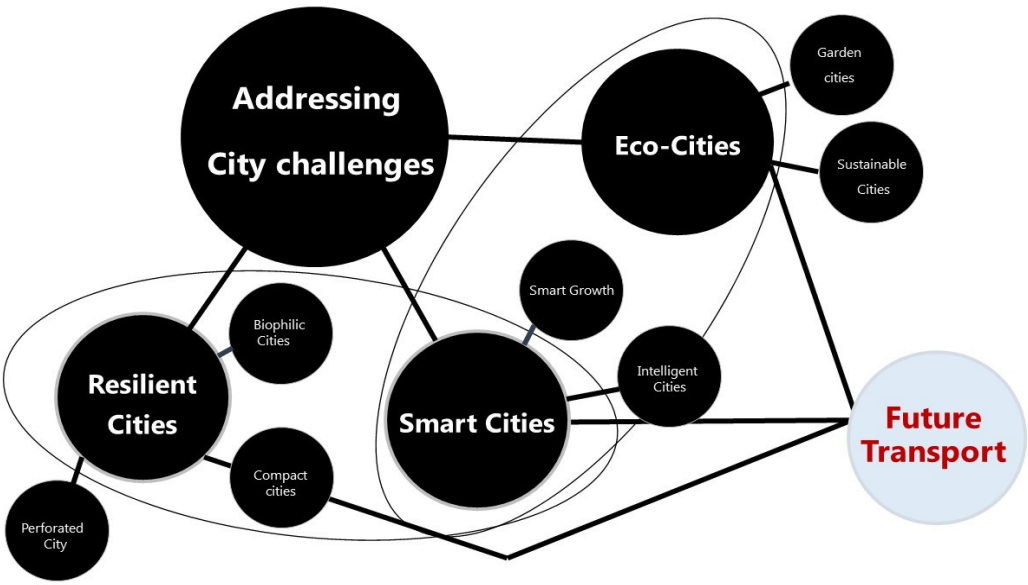


Figure 5 The City challenges/ Urban theories for urban dilemmas diagram source: own elaboration.

Author's reflection: reflected on Figure [5]

Much like Eco-cities focusing on cities that purposely cultivate a close relationship with nature and put a great importance to mobility and modality of navigating these spaces, Similar to eco-cities, Smart Cities seek to leverage technological advancements to improve people's quality of life by focusing on transportation and interconnectivity as critical components of the solution . Resilient Cities include mobility as one of the components that equip cities with the necessary tools to adapt to challenges by providing a sustainable network of communication within the city. Compact cities and Biophilic Cities share much of the same attributes when it comes to their mobility and transportation focus, these examples come together with concepts as infill and land preservation by attempting to diversify mobility means and design inclusive transport, although quite differentiated as futuristic development models, when it comes to mobility, they collide into enabling accessibility focused interventions, taking away a founding component at each one of these concepts. Although this is a commonsense conclusion, the processes required for the application of these ideas are heavily emphasized in this commonsense conclusion. In order to "effectively" translate eco-cities, smart cities, or resilient cities into their respective contexts, a special emphasis must be placed on transportation planning and mobility inside cities. When we take a hard look at each of these concepts, we can all agree that transportation and transit play a crucial role in both their development and their eventual success in the marketplace.

2.2 Cities and Transport | Let's talk about cities in the past (a futurist vision)

"Cities have the power to provide for everyone simply because, and only when, they are built by everyone" is a part from author J. Jacobs' 1961 book The Death of Great American Cities (Jacobs, The Death and Life of Great American Cities, 1961).

The city has been both a playground and center of attention forever, for both architects and planners wanting to guide their development. One of the most

futuristic visions of the time came in Harvey Corbett's "Scraping City", a mockup vision under the title "The wonder city you may live to see" (Corbett, 1996).
This futuristic image, which was inspired on a popular scientific mockup first published in 1925, surprised many people and provided them with a new perspective on the future. A sky-high density skyscraper with four levels that descend into the subterranean, with pedestrian traffic, slow motor traffic, fast motor traffic, and electric trains being the primary categories . Even if these notions about the future city, the role of transportation, and densification, or as Corbett referred to it, "crowding," were daring and provocative, they were not a far-fetched dream.

Corbett, in contrast to doubters, did not feel that the future would entail the decentralization of cities . To the contrary of the long-standing studies of architecture, city planning, and current words, he equated city life with increased congestion and crowded conditions. Corbett was a visionary who influenced cities, mainly Manhattan. (Schmitt, 2015)

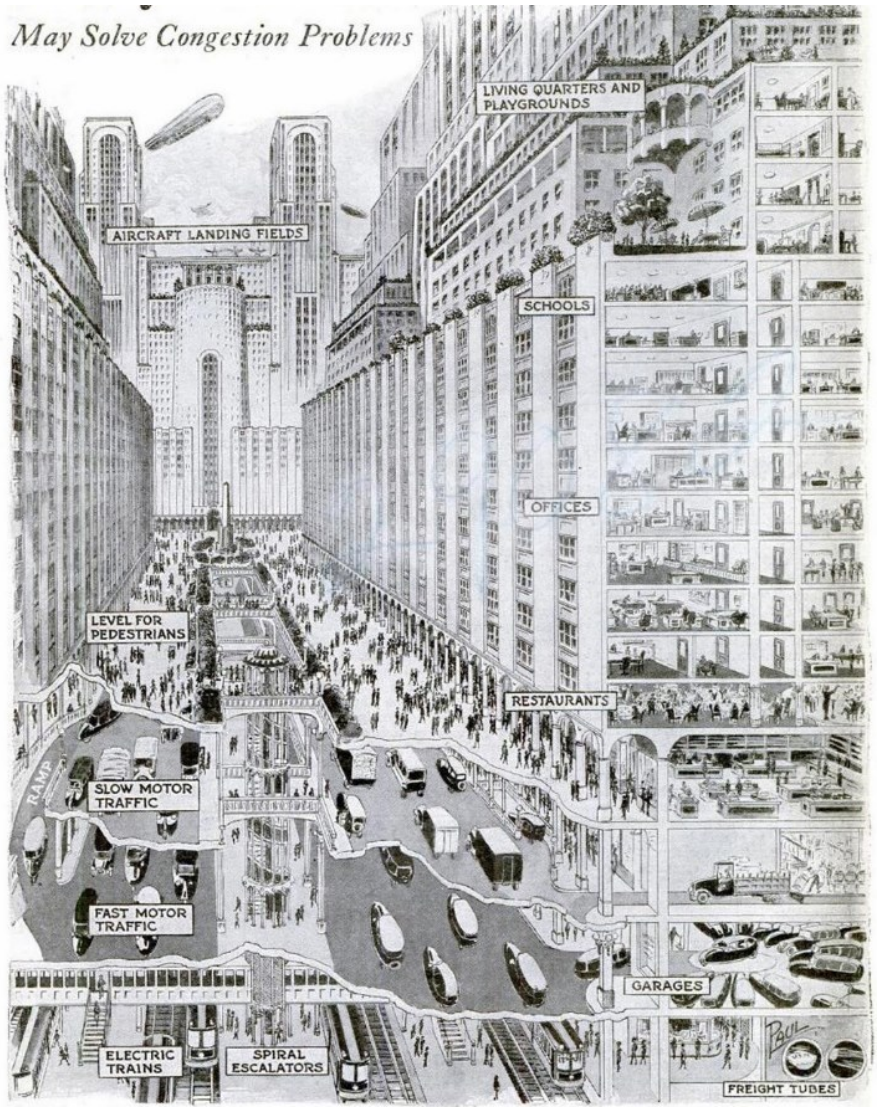
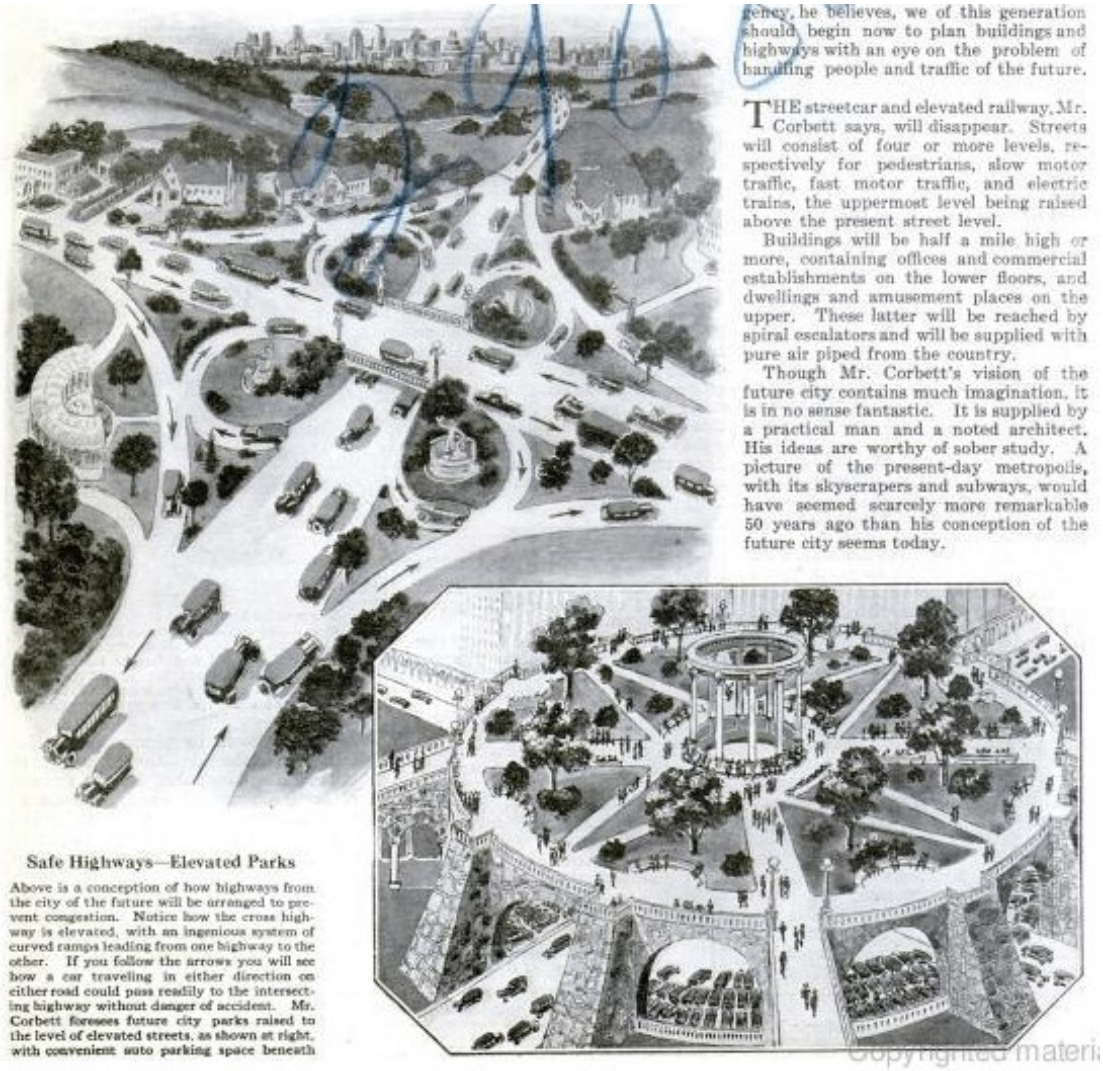


Figure 6 Harvey Corbett futuristic City (1925) source: The street Blog 2015, online source: https://usa.streetsblog.org/2015/08/13/the-future-american-city-as-imagined-in-1925/



Safe Highways—Elevated Parks

Above is a conception of how highways from the city of the future will be arranged to prevent congestion. Notice how the cross highway is elevated, with an ingenious system of curved ramps leading from one highway to the other. If you follow the arrows you will see how a car traveling in either direction on either road could pass readily to the intersecting highway without danger of accident. Mr. Corbett foresees future city parks raised to the level of elevated streets, as shown at right, with convenient auto parking space beneath

ency, he believes, we of this generation should begin now to plan buildings and highways with an eye on the problem of handling people and traffic of the future.

THE streetcar and elevated railway, Mr. Corbett says, will disappear. Streets will consist of four or more levels, respectively for pedestrians, slow motor traffic, fast motor traffic, and electric trains, the uppermost level being raised above the present street level.

Buildings will be half a mile high or more, containing offices and commercial establishments on the lower floors, and dwellings and amusement places on the upper. These latter will be reached by spiral escalators and will be supplied with pure air piped from the country.

Though Mr. Corbett's vision of the future city contains much imagination, it is in no sense fantastic. It is supplied by a practical man and a noted architect. His ideas are worthy of sober study. A picture of the present-day metropolis, with its skyscrapers and subways, would have seemed scarcely more remarkable 50 years ago than his conception of the future city seems today.

Figure 7 Harvey Corbett futuristic City (1925) source: The Urbanist 2015, online source: https://www.theurbanist.org/2015/08/12/futurism-did-they-get-it-right/

The 1930's has a time for change and new challenges. Le Ville Radieuse (The radiant city) was a futuristic masterplan of a contemporary city that remained unrealized as a tabula rasa approach to the European vernacular cities. However, this remains an important masterplan in echoing a new way of thinking. This masterplan was introduced by Le Corbusier in his book of the same name, published in 1933. Despite its contentious and perhaps severe structure, the goal of this masterplan was to provide people with a higher quality of life. Modern urban planning and density typologies have been impacted by the ideals proposed by Le Corbusier. In this futuristic metropolis, a multitude of prefabricated sky-high density structures will be constructed on a geometrical Cartesian grid, creating a dense urban environment. Within this project, there was a clear separation of zoning that was coupled to an infrastructure grid and public landscapes that were positioned in

the core of this future modernist concept. Separating residential and business zones from automotive usage is accomplished through the use of subterranean transportation. (M. Montavon, 2006), (Merin, 2013).

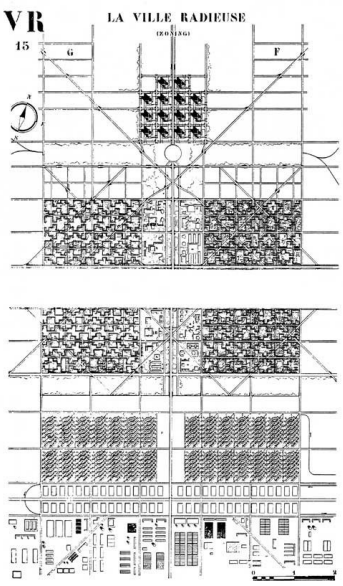
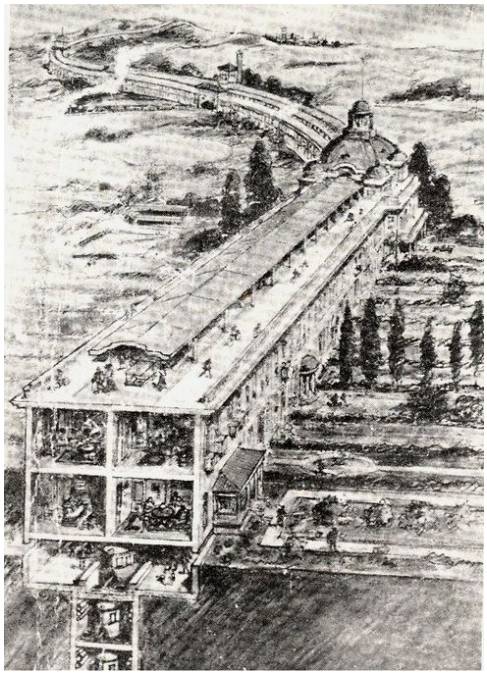


Figure 8&9 Le Corbusier (1933), "AD Classics: Ville Radiuses / Le Corbusier" source: via labourbanisticaventura.voila.net

In the 1910s, Edgar Chambless published "Roadtown," a book that is very contentious because it contains notions that are radically innovative for the time. The novel depicted a forward-thinking new metropolis that was anchored on transportation and the demand for mobility; this specific city was a direct competitor to urban sprawl in terms of planning and design. The city was a ribbon-like development built along a railway line with a high density that focused all development along a horizontal line where transportation, mobility, and activities were horizontally positioned and integrated. This form of development sought to preserve the surrounding land's scenery and agriculture. Chambless lobbied for his laydown tower but was never able to get the project off the ground. Regardless of how utopian this concept was, its effect of a metropolis directed by transportation, based in and grown by it, was subsequently partially translated in a number of current works. (Chambless, 1910). “Road Town transportation includes all the links in the system of transportation automatically coupled into one system. This is what I mean by a new conception of transportation” (Edgar, 1910, p. 21).

What Chambless meant was that transportation should be viewed as a whole system, from the modes of travel to their systems, components, and application in

conjunction with urban development and land use. Road Town believed everything to be a mode of transit, arguing that the one and the above are so inextricably linked that they form a cohesive system. Roads, transit patterns, land development, distribution of products, and farming have all been compartmentalized, conceived by distinct brains for a restricted collective goal (Chambless, 1910).



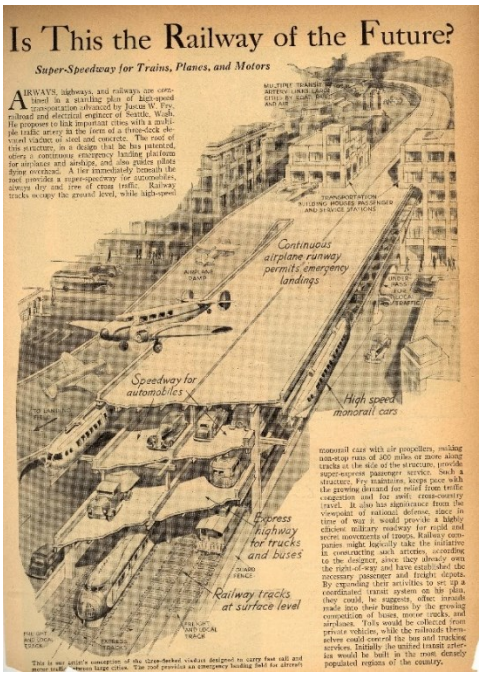


Figure 9 & 10 Edgar Chambless – Road Town, 1920. Railway and self-published by public promenade above Source: NY, Road Town Press [1910], [6],172 pp

Author's reflection on Chapter 2.2:

The first formal urban planning crises emerged in the 1960s, when the technological reason behind blueprint design came under scrutiny from a number of groups. Cities are steered by transportation, both in terms of demonstrating futuristic ideals for cities and in terms of the impact they have on the rest of the globe. While they emphasized future concepts centered on or near transportation, regardless of how contentious or implausible their atopies may sound today, they affected both their personal and professional life by urging people to seek a fresh viewpoint or modify their traditional thinking. Other Frank Lloyd Wright works, such as Broadacre City (1932), La ciudad lineal (1882), and Michael Graves and Peter Eisenman's The Jersey Corridor (1965), all share similar perspectives on the not-too-distant future, with an emphasis on density, transportation-centered

development, close proximity of services, and the overall quality of urban living. Purwanto and Darmawan (2014) assert that "when we think of cities, we think of transportation; the two are intimately linked and influence our connection with cities" (Purwanto E. &., 2015, p. 25).

2.3 Urban growth and the comet of sprawl

Urbanization began with Mesopotamian settlements over 5000 years ago, but they were little creatures. The upward trend began during the medieval period and has continued through the Industrial Revolution's boost to the present day. According to Mumford, the village is the ancestor of the city during the Neolithic period, when the economy shifted from foraging to food cultivation or farming. This town is characterized as modest and basic, yet has city-like features such as palisades, food storage, permanent housing, garbage collection, and burial grounds. At this point, he asserts that the interaction between nature and city is harmonious (Mumford, 1956, pp. 382-398). According to Kingsley, prior to the 1980's, we could not recognize large-scale urbanization since the urban-rural divide was dominating. (Davis, 1965, pp. 3-15) From the mid-twentieth century, the urbanization process started increasing, more rapid that the boom of the industrial revolution surpassing it many times over. (S. Davoudi, 2002, p. 269).

During the initial stage of urbanization, the number and size of cities varied according on the availability and productivity of agricultural land. Cities were mostly concentrated in valleys and river basins such as the Nile, Fertile Crescent, Indus, and Hwang Ho. As a result, population growth in any one city was constrained. Construction of large-scale river and sea transportation networks, as well as roads for chariots and carts, initiated the second stage of urbanization (Davis, 1965). As a result of surplus grain and oil production for export, agriculture, trade, and industry grew, complementing the religious and political specialization that dominated the previous stage. In other situations, such as the Greek city of Megalopolis, the population of lesser places was consciously concentrated in a single major core, a planned reproduction of a process that occurred less deliberately in other cities (Davis, 1965).

Employment and development were given emphasis in the late 19th and early 20th centuries (Grübler, 1990), (Anas, 1978), (Ween, 2012) .

Clark characterizes urbanization as the process of establishing a world dominated by cities and urban ambitions (Clark, 1982, p. 231).
The growth of great cities and their increasing spatial influence facilitated a shift away from mostly rural to predominantly urban areas and lifestyles that impacted the majority of countries over the last two centuries. It is critical to distinguish between two separate phases of urban development: urbanization and urban expansion (Clark, 1982). Utilizing Clark's definition as a starting point Urbanization is a geographical and demographic phenomenon defined by the growing importance of towns and cities as population concentrations within a given economy and society.
The effect happens when the population distribution changes from being largely concentrated in small towns and villages to being heavily concentrated in urban regions. Urbanization, on the other hand, is a non-spatial and social phenomenon that refers to the changes in behavior and social interactions that occur on social levels as a result of people living in towns and cities. Additionally, urbanization is described as 'the process by which individuals migrate from rural to urban regions as a result of population growth. (Nations, 2005).

In the late 1950s, urbanized areas in the United States of America expanded rapidly outside their urban cores as a result of the suburbanization process of residence, industry, and commerce, which encroached on significant amounts of farmland and forest, had a detrimental effect on the environment, and exacerbated traffic congestion Urban sprawl is a term used to describe this trend of uncontrolled urban expansion (Zhang, 2004).

“Spraw”l refers to an unplanned and illegal development pattern, generally on the outskirts of a city, typified by haphazard and fragmented building of homesteads, commercial districts, industrial regions, and other non-conforming land uses (Rahman, 2008, pp. 19-23).

The concept of sprawl suffers from an ambiguity in definitions, there are many perspectives defining the process the impact on territories, cities, however the Oxford Dictionary in 2000's defined sprawl as: "A wide area densely populated with structures that stretches in an unsightly manner from the city to the countryside" (Dictionary, 2000). On the other hand, an older definition by Ottensman in 1977 defined it as: "The dispersion of new construction on small plots of land that are insulated from one another by open space" (Ottensmann, 1977, pp. 389–400).
This morphological transition was aided by contemporary transportation technology and the construction of transportation infrastructure networks, resulting in vastly expanded and functionally dispersed urban districts that ate up cheaper and more accessible land in the suburbs. (William D. Anderson, 2001). "The phrase "urban sprawl" refers to low-density, automobile-oriented population patterns with insufficient comprehensive public planning." (Bruegmann, 2006). Sprawl began in Europe in the eighteenth century with the rise of the middle class, resulting in congested and troublesome cities such as London and Paris[5].

Although the city's economic importance has increased, it was congested, loud, and dirty, making living unpleasant and fueling anti-urban views. As a result, the increasing middle class grew to value tranquil, clean, and natural home suburbia living. (Bruegman, 2005).

Suburbanization truly began with the establishment of the railway system in the mid-nineteenth century. Citizens traveled from rural regions to cities in pursuit of work during the industrial revolution, completing the process of urban expansion and changing cities into both urban and suburban districts. By the 1930s, the bus system, as well as private vehicle ownership, had contributed significantly to the process of sprawl becoming a reality. While the rise of sprawl in North America and Europe are analogous in certain aspects, they vary when it comes to the more complicated characteristics associated with Europe. Increasing investment in the

[5] *Cities were very dense, with little space and constant pollution, functions and services of production were often found into the same structure and space.*

highway infrastructure has supported the rise of suburban regions in North American cities, making suburban development even more enticing. However, European towns are focusing on a slower purchase of private cars and relying more on the public transportation infrastructure. European towns are evolving in the opposite direction of the expanding urbanism of the nineteenth century, thanks to the notion of "Garden Communities"[6].

For a long period of time, urban sprawl has been a negative presence, resembling possibly the most significant shift in land use in Europe and northern America's cities. This might be considered a cornerstone of modern town planning. Taking center stage and posing a continual issue, sprawl has been the subject of several theories addressing both its prevention and aftermath, as well as the influence of sprawl on land use, eventually defining the function of transportation and mobility in cities.

2.4 Compact Neighborhoods

Compact and livable urban communities attract more people and economic capital than other sorts of neighborhoods . The creation of such towns is crucial for urban sprawl reduction and environmental protection . The adoption of redevelopment plans and zoning restrictions that direct housing and job growth into urban centers and local commercial areas in order to create compact, walkable, bikeable, and transit-friendly hubs further complicates the concept of dense communities. Numerous characteristics of compact neighborhoods emphasize the following :

Neighborhoods with a variety of uses- It is typical to accommodate a variety of different applications within a single structure or group of buildings. This phrase refers to any combination of residential, commercial, industrial, office, institutional, or other land uses, as well as a single land use, in planning terms. This can help

[6] *Ebenezer Howard who created a movement centered on satellite cities connected by rail transit access*[6] *. The concept of this movement was based in Real estate development with rail as the primary conduit between developed areas*

lessen reliance on automobiles, which are subject to their own set of zoning restrictions .

As a result, more individuals will be able to dwell in the city . Additionally, many urban planners believe that a scarcity of affordable housing has a negative effect on a city's overall health, in addition to the discontent felt by families unable to find a place to live . Consider the following imaginary scenario: Inadequate affordable housing may make recruiting low-wage workers more difficult, placing additional burden on transportation infrastructure .

2.5 New Urbanism

The New Urbanism or 'neotraditional planning' movement in the United States has emerged as a substantial alternative to the conventional patterns of low-density, automobile-dependent land development . New Urbanism began as a little experiment in the 1970's and 1980's. Since then, its influence has grown enormously (Pyatok, 2000, pp. 803-817). The concept itself was an antagonist to the phenomena of sprawl and land-consumption, believing that land is invaluable resource that should be traded as it won't always be available.

The New Urbanism has caught the American public consciousness in a way that no other urban planning movement has in decades. New Urbanists are attempting to change the character of the American metropolis amid considerable hoopla by reinstating conventional conceptions of community planning and adapting them to a range of urban and suburban contexts. The New Urbanism movement began as a reaction to conventional suburban planning techniques that date all the way back to the 1940s in the United States . According to New Urbanists, the decentralized, automobile-oriented suburb is a recipe for disaster . Occasionally referred to as "neotraditional" or simply "traditional neighborhood development," it is not a "new" concept (nor, as I will argue below, is it "urban"), but rather a systematic integration of a variety of known and long-used planning and architectural methodologies .

What is novel and distinctive in new urbanism is the way these technologies are packaged in a unified ideological package (Christoforidis, 1996). However, the

concept's origins may be traced all the way back to the official founding of a "Congress for New Urbanism" in 1993 and the adoption of a formal Charter by the Congress in 1996 (Marcuse, 2012, pp. 4-6).

The New Urbanists advocate for the incorporation of mixed uses (commercial, civic, residential, public spaces, and others) in each town. The objectives are to provide jobs close to inhabitants' homes and to enable residents to walk or bicycle to their destinations (Day, 2003). Similarly, New Urbanists advocate for areas to embrace alternate modes of transportation in order to reduce reliance on automobiles, especially transit. The concept finds many common grounds with Transit oriented development, something Calthorpe acknowledge in his book the next America metropolis published in 1993.

While New Urbanist philosophy stresses the value of variety in neighborhoods, New Urbanist practice offers few clear measures to promote diversity. New Urbanism promotes variety primarily through promoting a range of dwelling costs and styles within each neighborhood (Day, 2003, pp. 83-95).

The widespread perception among critics is that New Urbanism ignores present social and economic realities . According to this view, the automobile, affordable energy, computers, telecommunications, new construction technologies, multinational corporations, and global trading have rendered conventional city-building procedures outdated (Cliff, 2002, pp. 261–291).
With the emerging concept of ‘New Urbanism’, a return of TOD along transportation routes is regarded as a resurgent ideology. It is being viewed not only as a financial basis, but also as a means of long-term growth.

We define planning as the process of determining the most appropriate future course of action through a sequence of alternatives . The term determining is used in two distinct senses: to ascertain and to discover. Given that appropriate is a criterion for evaluating desired scenarios, planning includes an understanding of aims, action embodies specifics, and so we face the question of relating general ends and particular means . Additionally, we observe from the definition that action

is the end result of planning efforts, and so, a theory of planning must address issues of implementation (Faludi, 1978). With the advent of New Urbanism, a revival of TOD along transit routes is considered as a resurgent concept. It is regarded as both a financial basis and a means of long-term success .

The overarching goal is to cluster urban development around stations in order to increase transport use while also connecting current and prospective growth regions to transit routes (Curtis, 2009). Politicians and planners worldwide are promoting this system not only to improve public transit use and reduce greenhouse gas emissions, but also to provide more mobility options for today's complicated lives and business operations . A transit station naturally creates a catchment area for urban activity, which distinguishes it from other urban growth models .

2.6 Defining Transport

Transportation of goods or people has been for as long as humans have existed. On the other hand, the methods of functioning of this movement have altered over time . This phenomenon is explained by the move from animal to steam and then to fossil fuel power . In this way, mobility, unlike machines, has a social dimension . Human beings overcome this illogical barrier of physical isolation through transportation, allowing a given flow of resources to produce greater results (Bonavia, 1936, p. 189). Additionally, it fosters homogeneity among a country's citizens, and this sense of belonging increases political cohesiveness . Transportation, as the de facto barometer of economic, social, and commercial growth, has united the entire world. It disseminates ideas and inventions to the populace and has made a significant contribution to civilization's growth (Ogburn, 1946, pp. 373-379). Transport may not be a fundamental requirement in human nature for critical commodities . It is a vital component of culture, serving as the defining characteristic of civilization (Ambaprasad, 1960).
When we see mobility as a deliberate, meaningful – and hence cultural – act, we must consider both the material circumstances and political implications of transportation networks.

The growth of transportation is currently of the utmost socioeconomic and commercial importance. The transport industries, which are concerned only with the movement of people and objects, have contributed to one of the most significant human activities at every level of civilized civilization. It has a critical role in the diffusion and development of culture. As a result, a culture without a sophisticated mode of transportation stays primitive (Jagadish, 1998).

Prior before the invention of any other mode of transportation, mankind went on foot. Lower Mesopotamia created the wheel about 3500 BC, and the first wheel was constructed of wood. Initially, water transportation was accomplished by the use of a canoe-like structure "built by burning logs and digging the charred wood . Around 3100 BC, the Egyptians invented the sailing boat, while the Romans later built highways across Europe .

Transportation has evolved in unison with human culture . It evolved through a variety of stages, including the hunting stage, pastoral stage, agricultural stage, industrial stage, and commercial stage . Humanity has made numerous improvements in the field of transportation while also contributing to civilization's progress . Roads did not exist in the pre-human era, and people relied on walking for their livelihood and social life. In Paleolithic times, long distance walking trails arose as trading routes.

2.7 Placing Transport and Mobility

Transportation is a significant component in shaping how urban areas are organized spatially. Medieval towns were designed for walking, which necessitated the separation of dwelling and working areas (Wegener, 1995, pp. 157-162).

In general, transport refers to any mechanism that is used to transport an object from one point to another .The term "transport" refers to the movement of persons or things between points of origin and destination. A mode of transport is a vehicle or a system of vehicles, such as buses, trains, or other modes of transportation. Transportation is defined as the movement of goods and people from one location

n to another . Mobility, on the other hand, or the capacity of freight or persons to change their physical positions, is a fundamental component of any definition of transportation. The ability—and necessity—of transporting large amounts of commodities or large groups of people across enormous distances in comfort and safety has long been a gauge of civilization, particularly technological advancement. Humanity's existence altered tremendously with the invention of the wheel. Individuals could travel quicker and further as a result, seeing more, conquering more, and exploiting more resources.

The study by Mitchell and Rapkin published in 1954 “Urban Traffic- A Function of Land Use” as a study seminar, was the first link between land use and Transport. This publishing puts a in depth analyses to how transport and land use are interlinked and the correlation between the two, activities connected with certain land uses could be quantified, quantitative estimates of the traffic associated with those land uses could be generated. Traffic volumes in urban areas were directly tied to land usage (Banister D. ,., 1995, pp. 1-16).

The decentralization of cities, the creation of discrete centers of activity within the sprawling city, and the emphasis on certain tasks (e.g., specialization in banking and financial services) all contribute to this rise in travel (Banister D. ,., 1995). However, the connections between transportation and urban growth are not fully understood, even physically. Along with physical connections (such as density), there are important economic considerations (such as "rent levels and land prices"), social concerns (such as equality and distributional issues), and environmental concerns (such as "quality of life").

Mobility research contributes significantly to the fields of transportation (Knowles et al. 2008; Shaw and Docherty 2014), transportation geography, and transportation planning, in part because it can assist in "facilitating the quantitative–qualitative gap" (Goetz et al. 2009; and cf. Jensen et al. 2014).

Coming back to our topic, the origins of TOD date all the way back to the dawn of civilization, when humans settled along the most available sources of transit, such

as water. Regardless of transit system modifications, the requirement to reside near a handy method of transportation remains. Sustainable transport is outlined in the Brundtland Report (World Commission on Environment and Development, 1987) as "meeting current transportation and mobility demands without endangering future generations' ability to meet these demands" (Black, 1996).

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3 THIRD CHAPTER | OUR COMPLEXITY

3.1 Exploring Complexity

The term 'complexity' is derived from the Latin 'Complectere,' which means to wrap or enclose, and the Greek 'Complexus,' which means plated (Mitchell M. , 2009, p. 4). The term's origin just serves as a gateway to the plethora of possibilities that this word implies. Complex systems are ubiquitous; they are characterized as a collection of elements that self-organize and, in some situations, lean and evolve. This multidisciplinary area investigates how seemingly basic components, when combined, become complicated systems capable of self-adaptation (Mitchell M. , 2009, p. 13).

"How do we define complexity?" Upon first examination, complexity appears to be a fabric (complexus: that which is knitted together) of inseparably linked diverse constituents: complexity embodies the paradox of the one and the many. Arguing that complexity is the web of events, acts, interactions, retroactions, decisions, and chance that weaves our amazing world together (Morin, 1990, p. 21).

The purpose of a complex approach to the city is to reconnect disparate types of information that have been severed by disjunctive thinking. Urban complexity may be thought of in terms of consecutive urban scales that reflect hierarchical organizational levels within a metropolis. Certain groups of consecutive levels in these hierarchies have a considerably more defined organization than others, which are much looser (Salat & Bourdic, 2012, p. 27).

Models for population, land use, and transportation planning have incorporated elements of systems dynamics, cellular automata, agent-based modeling, and network analysis. demonstrating how complex methodologies have been utilized to address issues such as housing and anticipating people's movements, most frequently in conjunction with deterministic, large-scale urban models (Portugali, Meyer, Stolk, & Tan, 2012, p. 22).

City planning in the modern age is characterized by new environmental and social concerns, as well as a broad range of industrial ecology-related difficulties (Portugali, Meyer, Stolk, & Tan, 2012, p. 21).

The phrases "complex systems" and "complexity theory" are sometimes used interchangeably. Nonlinear behavior, feedbacks, self-organization, irreducibility, and emergent features are all characteristics of computational systems science (CSS). Many homogenous components that do not interact with one another in a cohesive manner are the hallmark of problems of disordered complexity. We come into these issues while trying to represent gas behavior in physics or in markets when there are a large number of buyers and sellers. By averaging the behavior of populations, statistical tools can be used to provide insight into the system's dynamics (Salat & Bourdic, 2012, p. 29).

As Waldrop stated in 1992, ‘Where the components of a system never completely lock into place, but also never completely dissipate into turbulence, our dynamic reality, including life itself, emerges' (Waldrop M. , 1992, p. 12).

We cannot get a better understanding of urban dynamics, identify intervention opportunities, or address dynamic problems by just publishing aggregate data in reports on urban performance and sustainability . To advance, it is vital to detect and model many sorts of interactions (system, network, and agent) . In this context, CSS models and approaches may be utilized to get a better knowledge of urban dynamics and, as a result, to guide planning and management choices more effectively (Root, Zurich, & Hillier, 2012, p. 135)

3.2 Considering the role of Complexity in Planning

Various types of urban settings surround us. In this kind of situation, it's necessary to look for the underlying truths that are hidden behind the surface of things. Our comprehensive research is built on fundamental universal laws that govern cities, galaxy clusters, species' evolutionary trees, and economic cycles, as well as their frequency and amplitude (Nottale, 2000).

According to the latest morphological theories, forms are not only independent entities but also, and most importantly, totalities. Because of the hierarchical structure of short- and long-range coupling forces, these complex systems can't be disassembled into their constituent pieces (Salingaros, 2006).

Consider the complexity of a city in terms of the different sizes that correlate to different organizational levels within a metropolis when thinking about urban complexity. In these hierarchies, there are certain groups of sequential levels that have a substantially more defined organization than others, while others have a significantly looser structure (Salat & Bourdic, 2012).

Based on fractal principles, the sizes and distribution of land uses and networks are determined (Frankhauser, 1994). A city's economic activity is concentrated in a tiny region because of the city's fractal layout. As a result, more comprehensive studies of urban density and the hierarchy of major places are now available.

Complex systems theory has unearthed the concept of resilience, which is worth further study. Cities' resilience, defined as their ability to withstand and recover from both internal and external stressors, crises, and shocks, is a topic that deserves further study in light of the present political climate. Many difficulties will confront cities over the next century, including: water shortages, population growth, social unrest, the loss of natural resources and climate change (Salat & Bourdic, 2012).

As a city's stability is measured by its urban tissue's resiliency, its long-term economic worth is affected. A city's ability to withstand natural disasters is directly

related to the amount of redundancy in its infrastructure. In densely populated and well-connected metropolises, the use of functional mix can result in significant financial savings (materials, energy). The complexity and density of feedback loops makes it simpler to handle residual demands in a circular economy.

System dynamics models, as we've seen, are a popular choice for operational settings because they can build global structures that resemble real cities. On the other hand, Gilbert and Troitzsch (2000) identify four issues with this strategy: Micro-level dynamics are generally disregarded, parameters are often over-aggregated, and the consequent global implications are often impossible to forecast. One of the most impressive aspects of employing agents is the ability to show how decisions are made and how they might change (Salat & Bourdic, 2012).

Creating a sustainable city looks to necessitate a higher reliance on one's own resources in order to reduce the flow of rubbish and conserve energy and resources (Grimmet et al., 2008; Jacobs, 1969). First, we need to examine and duplicate the characteristics of existing linkages between various land uses, enterprises, communities, and levels of government in order to promote more connectedness. Complexity theories of cities have enriched our knowledge of cities and spawned an entire field of research, most notably urban simulation models.

The integration of complex systems into planning and cities occurred in two stages: first, physicist Peter Allen "adapted Prigogine's dissipative structures to the dynamics of urban dynamics"; and second, "scholars of urban planning applied the concept of complexity to twenty-first-century planning difficulties" (Portugali, Meyer, Stolk, & Tan, 2012, p. 18)

3.3 The Integration of complexity into the urban context

“The disorder of the city, it’s a complex order. This order is all composed of movement and change, and although it is life not art, we may fancifully call it the art form of the city (Jacobs, 1961).” Since the Jane Jacobs interventions in the view of cities, they've become increasingly complicated systems.

In Mellanie Mitchell's book, 'complexity, A Guided Tour,' she uses examples such as the immune system, ant colonies, and economic sectors in which the constituents or entities are individuals to show the meaning of complex systems. demonstrating the necessity of group intelligence in order to grasp the complexities of the world (Roo, 2012).

We can't have a system without the presence of other systems that are always interacting and evolving. Due to the term's multidisciplinary application, it is difficult to bring this phrase closer to our topic. A logical-positive viewpoint is used to draw a link between planning and complexity; alternatives reflect an imperfect reality in which future facts are not yet known (Roo, 2012). Unconventionally, it was thought that if we had enough money and time to study everything there was to know about our "imperfect" environment, we could learn everything there was to know. According to Schoen (1938), (Simon, 1957). By introducing system theories and emphasizing the technical and communicative rationales in planning and decision-making, we may pave the way for a deeper knowledge of complex and complexity theory and planning (Portugali, Meyer, Stolk, & Tan, 2012).

Waldrop adds that dynamic reality encompasses life (addressed here are multidimensional and all-purpose, all-interest entities), including human life, which exists on the precipice of order and chaos (Waldrop M. , 1992).
The urban complexity of cities is not determined just by the components they include, but rather by the city's capacity for various actions (Portugali J. , 2016)
Habraken feels that while the city as a material component is a relatively simple system, when combined with human components, the city becomes complicated (Habraken, 1998).

The complexity of urban life necessitates planners to engage in dynamic processes at all times. Cities may work without external control by self-coordinating and hosting multiple actions and activities that allow for adaptation thanks to transportation, which offers some equity to these systems (Andersson, 2017).

No question, by moving from a bottom-up to a top-down complicated system, we are embracing a new level of risk and uncertainty (Mitchell M. , 2009).

Author's reflection on complexity, city and TOD:

After taking into consideration systems theory and complexity in relation to our topic, we must return to the Habraken definition and appreciate the key ingredient that must be included in the mix, which is people, who we may consider to be the center of complexity in our topic.

Complexity may be understood and guided through the use of transportation, land use, urban planning, and public places, among other things. Investigations have demonstrated that both urban complex systems, traffic flows, city networks, and the process of human mobility display a scaling property, which is a trait in which the size of the system rises as the complexity of the system grows

Cities are already complex structures, referencing to the example of the tree and the leaf by Mitchell, M. Complexity a guided tour (Mitchell M. , 2009), explaining how each component of the city is similar to the veins of the leaf. As a result, transit-oriented development reflects the complexities of urban planning and transportation planning and implementation.

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4 FORTH CHAPTER | TRANSIT ORIENTED DEVELOPMENT

4.1 Theory unveiling. Calthorpe's TOD

Peter Calthorp was the person behind TOD's definition and implementation. He was born in 1949-in in London but raised in California. His perspectives were shaped while he was a student at Antioch College and afterwards at Yale's Graduate School of Architecture . He then became the director of "The Farallon" institute, which concentrated on sustainable gardening, water conservation, and environmentally friendly practices .

This experience empowered him to create his own sustainable design firm . He joined the Congress of New Urbanism, bringing his sustainable urban design ideals to this chapter . These beliefs were later contextualized in Calthorpe's 1993 published book "The Next American Metropolis" in relation to the emergence of TOD .

Sim Van der Ryn, founder of "The Farallon" institute, served as an inspiration for his professional endeavors. He was a leader in the sustainable development movement and was instrumental in establishing UC Berkeley's reputation as a socially and environmentally responsible institution.

Van der Ryn and Calthorpe worked in design studios to further test his concepts . Calthorpe later became a partner in Van der Ryn's architectural studio .Calthorpe characterized this period as being concerned with the environmental consequences of expansion. It wasn't until later in 1983 when with his own firm Calthorpe's

Associates started to shift his focus to urban new towns and suburban areas. (Katz, 2014)
In 1986, he co-authored the book "Sustainable Communities: A New Design Synthesis for Cities, Suburbs, and Towns," in which he discussed older cities as a paradigm for sustainable development, as well as communities, pedestrian-friendly urbanism, and sustainable architecture. At the time, his emphasis was completely on sustainable communities, with transportation being an afterthought.

Calthorpe concentrated on Ebenezer Howard's Garden City Movement as a sustainable approach taking as an example the New Town of Vällingby. Among other findings, he addressed the movement's significant reliance on commuter train. Though his theories on TOD were absent at the time.

His concepts matured after the publishing of "Sustainable Communities: A New Design Synthesis for Cities, Suburbs, and Towns". He extended his work to compact, traditionally informed designs called Urban Villages. He began to work with a focus on the technical basis for sustainable communities, incorporating "urbanism" to promote social communities, including in his projects affordable housing and mixed uses connected by a walkable setting.

The next step for Calthorp was investigating the theory of urbanism and environmentalism. With the procuring of a grand, he paired with Mark Mack also a professor at UC Berkeley. Together, they developed a new centric neo-traditional new tow concept called pedestrian pockets. In 1989, the faculty published "The Pedestrian Pocket Book," the result of student scenarios and caltrop testing . This book defined pedestrian pockets as a cluster of housing, services, and retail within a quarter-mile walking distance of a transit system . Duany and Plater-Zyberk, who embraced Leon Krier's original idea, inspired the principle of walking distance (Florida, 2017).

It was suggested by Calthorpe that pedestrian areas were a market-driven solution, rather than an aspirational notion of an automobile-free utopia. Automobiles, public transportation, and pedestrians may all pass through them with ease. It's important

to remember that the goal was to present a diverse range of options. Because mixed-use zones would accommodate a variety of modes of transportation, including walking, these pockets would extend the range of options available.

In 1988 Calthorp was working on the pedestrian pockets, when he was asked to join a project team for the metropolitan Portland, Oregon. This project evolved from the proposed Western Bypass suburban freeway to redefining Portland's metropolitan land-use plan. The project was called "Making the Land Use, Transportation, Air Quality Connection" or LUTRAQ .The LUTRAQ research compared options for developing interstate or rail corridors side by side . Calthorpe advocated implementing neo-traditional Pedestrian Pockets along train routes . The project's objective was to encourage nationwide development patterns that minimize land usage, automobile journeys, and air pollution (Michael Leccese, 2000, p. 103). Calthorpe aided the city in developing new zoning laws based on Pedestrian Pocket concepts in order to expedite this process (Michael Leccese, 2000).

In 1987, Sacramento County contracted Calthorpe to propose "Pedestrian/Transit-Oriented Development" in combination with the County's rail facilities. Although this was the first time the TOD name was used officially, Calthorpe continued to refer to his recommendations as "Pedestrian Pockets."

As he had previously done in 1989, Calthorpe was requested to assist by consulting on the TOD's governing zoning principles . In the fall of 1991, the group presented the ideas to over one hundred government officials, the commission stated. Dubbed the Ahwahnee Concepts, these principles laid the groundwork for the Smart Growth movement, New Urbanism, and TOD.

The West Laguna served as the prototype for the Pedestrian Pockets . The areas transitioned from conventional suburban development to a neo-traditional neighborhood connected to the town center by tree-lined streets . The planning process incorporated characteristics of the later TOD, such as mixed uses, pedestrian walkways, and riparian zones .

The housing was going to be built in the street frontage, the street was mainly narrow to encourage slow driving and security. This was the first time TOD has mentioned as a model itself. (Dunham-Jones, 2008)

For Calthorpe the shift from “Pedestrian pockets” to “Transit-oriented development” was simply rebranding. He consulted with Robert Cervero an expert in the field transportation. He swayed public opinion by demonstrating a link between urban densities and transit. Calthorpe examined the zoning regulations in Portland and Sacramento in order to encourage light rail and connectivity. The change of the name came as a tribute to the new focus of transit components. R. Cervero suggested “Transit-Supportive Development” but Calthorpe thought that “Transit-Oriented Development,” was a better branding. (Peter Calthorpe, 1989)

TOD was officially accepted in 1992 when Calthorpe introduced it at the congress of New Urbanism. New urbanism's charter of principles was summarized in 1993 by the Congress of the New Urbanism, which argued for rethinking public policy, a diverse population and use of neighborhoods, neighborhoods designed for pedestrians, public transportation, and automobiles, and cities and towns should be shaped by public space and institutions. Calthorpe claims that the goal of new urbanism is to prevent a sterile suburban character by learning from (previous urban planning) mistakes.

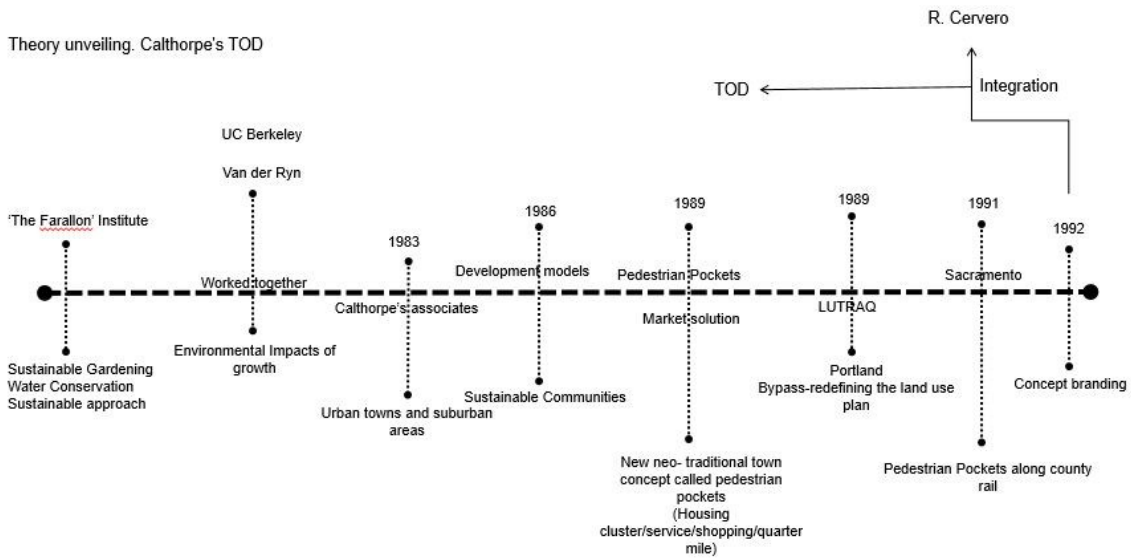
Calthorpe thought that new urbanism was the same response for environmental groups, neighborhood revitalization groups, and historic preservation groups. He thought that the principles of the new urbanism agenda bonded these groups by offering a common set of principles.

Soon after, New urbanism recognized that reproducible principles were critical to the widespread adoption of their ideas . However, many of their suggestions were prohibited by the existing laws, which were designed for automobiles rather than people. The reasonable next step would have been to intervene and amend the codes. Calthorpe provided a booklet outlining the steps necessary for good

planning that takes TOD into account. Shelly Poticha was a significant contributor to the guidebook Calthorpe was reinventing. "In 1993, Calthorpe released her guidelines in "The Next American Metropolis."

When the historical backdrop for the concept of TOD is considered, the design components and standards are unsurprising, as they are based on Calthorpe's concepts and synthesis of ecological", aesthetic, anti-sprawl, and equitable planning approaches.

Figure 10 The evolution of TOD in relation to Peter Colthorp's contribution/ Source: Author's elaboration



4.2 Transit-Oriented Development Origin

There are several implementations and planning attempts to respond to the continuous evolution of this notion. This evolution accrued when adapting the concept, considered its application context. However, these attempts were no recipe to a successful implementation. We must begin to remember puzzle pieces that brought this idea together, shaped or altered its emphasis as we examine the changes that this notion creates. Returning to the book that had a stronger impact on planners and the planning process, "the Life and Death of Great American

Cities" by Jane Jacobs and “Garden Cities of Tomorrow” by Ebenezer Howard in 1902[7].

The idea of TOD was completely or partially developed, but what really made a difference was the development of a tailor-made toolbox. "TOD is already viewed as a neo-traditional guide to sustainable community design and mobility," according to Carey Curtis (Curtis, 2009, S. 108). This concept was never fully acknowledged by Peter Calthorp, identified as the 'father' of TOD. Transit Oriented Development was simply a rebranding of an established definition, the transport and mobility were often co-dependent synergies in relation to the built environment that were bound to construct urban form. And this was nothing new to the world. At the turn of the twentieth century, the term TOD had a different connotation, owing primarily to the concept's importance as a market enabler (Hank Dittmar, 2004). By the early twentieth century, the notion of TOD had a different rationale, which was principally tied to the concept's influence as an enabler on the real estate market". TOD stood for "development-oriented transit," which meant that once transit was established, the area was transformed, bringing jobs and new construction to the region, hence increasing property prices.

Tracing back TOD's precedents would take us to Bristol, England in 1811. Blaise Hamlet constructed a group of cottages with asymmetric and picturesque aesthetics, where John Nash the English architect and pioneer of the picturesque aesthetic, created an inhabitable space where each cottage was unique surrounded by gardens and linked by an oval path that connected the cottages to one and the other around the sundial. For the Bristol workforce, these cottages were compact accommodation, situated in the vicinity of the factories with a walking orientation for transport. In its compactness and orientation towards a strong element of infrastructure, which in this case was a walking road, the above-described example was linked to the TOD theory.

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[7] *See Working Paper: “Histories of Transit-Oriented Development: Perspectives on the Development of the TOD Concept” by Ian Carlton(2009)*

The Bedford Park Master Plan of Jonathan Carr in 1875', following the beginning of transit-oriented development. For the middle-lower class that would no longer afford to live in the main city, Bedford Park was developed. The picturesque aesthetics that wanted to maintain the connection with nature but also provide a community inspired "Car". Bedford Park was an inspiration of the later garden cities, this project lacked the later garden cities planned social framework, but in this model , Carr provided a Club, a church and shops . "Bedford Park" was linked by rail to London's main station . To serve the huge number of middle-class residents that commute every day to the station, stores, schools, and events were constructed for residents to use during their trip (Creese W. , 1992).

In the late 1880s, the utopian architecture of William Owen, Alexander Harvey, and George Cadbury was located near the planned city of Bedford Park. They focused on improving workers' living conditions, inspired by the movement of arts and crafts.[3] As founders of utopian socialism, in order to improve living conditions, they built working villages, and leisure events were organized by communities and landscaped areas were always the secret to happy societies. The location of this project has been affected by the road and rail networks. But the place at the time was mainly associated with the movement of good and not people (Creese W. , 1992).

This village became the base of future garden towns and modern TOD, when Owen and Cadbury included Harvey for the construction of Port Sunlight. Cadbury established planning restrictions by requiring that one-tenth of the land be set aside for parks and recreational places; he also demanded that factories occupy no more than one-fifteenth of the land. Since the land was privately owned by the soap factory, which requested the construction to house the factory staff, such rules were easily enforced, making this project an integral part of the future garden cities (Knox, 2011).

Another influence was the Boston utopia of Edward Bellamy in 1888. As he, in an antithesis to what it actually was, reflected society. Many social and economic ideas

about the future projected many changes in the book "Looking Backward" that affected the planning sphere. Of course, his book was a utopian fiction at the time. (Bellamy, 1888)

The planned Riverside colony of Olmstead and Vaux in 1869 made a significant contribution to Ebenezer Howard's creation of the Garden City . The Olmstead ideal of how suburbs should look was known to be the Riverside Neighborhood. Riverside was a suburb of Chicago connected by railway. Olmstead's idea includes enough space for recreational activities, shaded parkways connecting Riverside with Chicago, streets that followed the curve of the land avoiding all right angles and intersection. He aimed to provide a romantic and scenic view of this community (Ward, 1993).

The TOD's beginnings may be traced all the way back to Ebenezer Howard's, "Garden Cities", who pioneered a system centered on satellite cities connected by train (Cervero R. , 1996). This movement was centered on the concept of real estate development, with rail as the major mode of transport between developed communities . Despite the fact that his views were based on London's deteriorating socioeconomic circumstances, his ideas were adapted for use in the United States . At the time, this migration occurred on the fringes of the majority of the country's largest cities

At the turn of the twentieth century, Sam Bass Warner investigated the origins of development-oriented transit in Boston, writes the author. The metropolitan region of Massachusetts has been described as a "two-part city," in which the city of residence and the city of employment are distinct. This was the next step in the evolution of public transportation (Warner, 1978).

Following the 1945 downturn and a lack of investment in public rail in the aftermath of WWII, mass production of the private automobile dominated the form of transportation.
President John F. Kennedy attempted to reverse this problem in 1964 with the "Great Society" initiative. The goal was to retain current urban values while

providing enough urban mobility via a mix of public and private modes. To help maintain this equilibrium, suburban commuters used the "Park and Ride" concept to access the public transportation system.

In the 1970's, transportation authorities established small real estate firms to develop or lease land next to transportation hubs as a means of financing transportation initiatives . This was ostensibly dubbed "join Development" (Cervero, Ferrell, & Murphy, Transit-Oriented Development and Joint Development in the United States:A Literature Review, 2002). These years, up to the 1980s, its invention garnered considerable interest as a novel financial instrument and local, regional, and state governments recognized that they might contribute to increased ridership by directing the type and scale of development on property adjacent to stations (Creese W. , 1992).

Calthorpe's modern definition of TOD is based on design criteria that municipalities are required to include into the planning process . The first indication of this occurred in the 1880s, with William Owen and Alexander Harvey's late utopian ideas for worker settlements that took road and rail infrastructure into account .
The aforementioned precedents, as well as Edward Bellamy's influence in 1888 with the Boston Utopia and Olmstead's influence in 1869 with the Riverside community, all inspired the development of Ebenezer Howard's garden city . Howard's garden city was a circular pattern consisting of houses with strict constraints on dwelling density and proximity to the central hub . A metropolis of the garden city was built by combining many garden cities and connecting them by inter-municipal railways . Due to its sway on neighborhood design, the garden city served as the most significant predecessor for the Calthorpe TOD development .

To construct Letchworth, the world's first garden city, Howard and Cadbury formed a joint-stock corporation in 1903 in partnership with Cadbury . Unified around an open-air park, which is ringed by public buildings and connected to residential portions by rail, the city radiates outwards into a network of corridors . The Master Plan included a central business district with radiating axes, a well-defined principal commercial corridor, and sectors for residential, industrial, and recreational

development. Furthermore, it is flanked by a barren greenbelt that evokes the "country" (Council, 2007). While subsequent impacts were felt, the majority of Calthorpe's ideas were incorporated into the creation of Letchworth .

Opponents such as Lewis Mumford in the early twentieth century endorsed Raymond Unwin's theories, arguing that the best growth of garden cities should prioritize people above automobiles. Calthorpe's instructions for developing them were eventually used to support these ideas.

Adopting a Mentality that is Oriented Toward the Future In the 1920s, Barry Parker created Wythenshawe, a satellite garden city that is still in use today. The city of Manchester supplies much-needed housing for the surrounding metropolitan area. In comparison to previous models, this one includes the "princess Parkway," a landscaped road connecting the two locations. This exemplified the concept's evolution, as garden towns were modified for the future, which included automobile use.

Soon after, the concepts of garden cities began to change away from prescriptive planning and toward planning with auto-focus . The notion of garden cities has been extended to auto-oriented countries that have lost their connection to the natural world .
Examine Robert Moses' design for New York City to see how he made the shift from natural and beautiful garden communities to auto-centric urban planning and development. His argument was that cities and automobiles were inexorably intertwined in the modern world. Ms. Jane Jacobs was his most outspoken opponent of this philosophy. For her, driving should always take a back seat to the city's extensive network of pedestrian pathways.

Leon Krier, a German urban thinker in the 1970s and 1980s, reinterpreted classical doctrines in reaction to modernism, (sprawl) (Terpo, 2018, pp. 522-533). He examined European communities on a block-by-block basis, connecting them via pedestrian-oriented transportation and defined the 10-minute or quarter-mile walk as a human-scale community suitable for walking (Terpo, 2018, pp. 522-533). This

concept was later integrated as the primary principle of Calthorpe's TOD (Terpo, 2018, pp. 522-533).

Leon Krier's plan was initially adopted at Florida's Seaside resort area (Terpo, 2018, pp. 522-533). This development provided all-in-one suburban solutions by placing water features, bike routes, and stores within walking distance of Krier's human-scale neighborhoods, thereby increasing density while maintaining open space. Infrastructure radiates out from the central business district, connecting buildings and services to automobiles and alternate modes of transit such as bike lanes and pedestrian paths (Terpo, 2018, pp. 522-533). Concepts all incorporated into the modern TOD (Terpo, 2018, pp. 522-533).

This rather controversial development concept is a living example into learning by implementation. Many of the components of TOD have seen a myriad of changes as the focus of the concept itself has evolved. Keeping in mind that on how the concept started and what were the later faced challenges we can simply state that, TOD is an ever-evolving concept (Terpo, 2018, pp. 522-533).

As we unveil the continues evolution of this concept, tracing back the influencers such as John Nash, Jonathan Carr, reflected in the table nr. 11 below we can understand why the concept, deemed necessary the introduction of specific components. The experience that Calthorpe gained by these architects and planning practitioners, was a form of experiment for his theory, since he “tested” the importance and influence into the urban condition of these components. Later on, the refined ideas of these concepts were part of this “The Pedestrian Pocket”, a project that descended from the “Garden Cities” of Ebenezer Howard, sharing a vision for this post- industrial culture of the mismatched suburban life, a space for Calthorpe to experiment on the notions of bettering the quality of life and respecting ecology.

Calthorpe in his Book the “The Next American Metropolis”, matured his experiment with the Pedestrian Pockets into what now we recognize as Transit Oriented

Development, as a response to a transformation that has already begun[8], referring to the car dependency and transformation of the urban space. The timeline of his "lessons learned" from case studies that he emphasizes on his book, "The Pedestrian Pocket", and later on "The Next American Metropolis" are reflected into the table 11.

Table 11. A timeline matrix on the development of TOD theory/ Source: Authors' elaboration

Author	*Year*	*Project*	*Contribution to theory*
John Nash	1811	Bristol, England	Picturesque aesthetics of planning with nature in mind, connected by transport (Walking)
Jonathan Carr	1875	Bedford Park	Developing near Transport and rail, providing services near the station as a service to people
William Owen & Alexander Harvey	1880	Planning Utopia	Nature in connection to the city (Later Garden cities)
William Owen & Alexander Harvey	1888	Port Sunlight	Cities with a focus on activities and public building connected by narrow paths
Edward Bellamy	1888	Utopia standards	People and nature connected by preserving 1/10 of land for recreation and urban parks
Olmstead & Vaux	1869	Riverside Community	The satellite city connected with the city by shaded parkway and narrow streets
Ebenezer Howard	1898	Garden cities	A city focused on a garden surrounded by

[8] *The pedestrian pocket refers to a response that the book defines as: the movement of people from the city center to the suburb, ending to the phenomena of sprawl and depending entirely on the car movement.*

			public buildings, and of which would radiate a series of avenues leading to residential areas connected by rail and surrounded by a minimal greenbelt
Sam Bass Warner	1900	Boston	The two-part city, the working city and the sleeping city connected by a transit development
Howard & Cadbury	1903	Letchworth	The first Garden city of residential areas connected by rail
Lewis Mumford & Raymond Unwin	1910	Theory	Garden cities should focus on pedestrian transport
Barry Parker	1920	Manchester	Satellite connection of a landscaped highway connection for people and cars "Princess Parkway"
Robert Moses	1939	New York city	Cities and automobile should be one. (Transit-oriented development)
Jane Jacobs	1961	The death and life of great American cities	Cities, neighborhoods should be pedestrian to preserve the core of their values
Leon Krier	1970-1980	Seaside Community	People should be able to feel human, neighborhoods should provide transportation alternatives within a 10-mile radius of walking

The basic premise is that urban growth should be concentrated around stations to encourage transit use, and that transit lines should be constructed to connect present and planned clusters of development (Bossard, 2010). Global politicians and planners support this system in order to promote public transit use and minimize greenhouse gas emissions while also giving better mobility options for

today's various lifestyles and business practices. A transit station has a particular advantage over other methods of urban development in that it naturally draws residents and businesses.

4.3 Theory unveiling, Defining TOD

Transit-oriented development is founded on the premise that people of all income levels may live and work in places with interconnected transportation networks that give extra mobility alternatives, allowing them to make some daily journeys via transit, walking, or bicycling instead of driving (CTOD, 2010).

Changing the character of cities in order to make them more accessible and mobile is the goal of transit-oriented development . It is feasible to build towns and metropolises that rely on public transportation and organize their lives around centrally located rail or bus terminals that serve as community centers by combining transportation and urban land use. (Zarba, 2017).

Transit-oriented development (TOD) has been identified as a type of sustainable urban transportation that fosters greater levels of human interaction (Bernick M, 1997). TOD is defined as "a compact, mixed-use neighborhood centered on a transit station that intentionally encourages residents, employees, and visitors to drive less and rely more on public transportation" (Bernick M, 1997, p. 5). TOD communities have the potential to develop activity rings around transportation routes. This kind of sustainable urban transportation is viewed as a remedy for both traffic congestion and the environmental challenges associated with transportation (Cervero R, 2008).

“TOD promotes mixed use in buildings, high density and pedestrian- friendly development around transit to promote transit riding, increase walk and bicycle travel, and other alternatives to car use. Aims to promote development without adding to sprawl, freeing open space and adding public transportation” (Dittmar H. G., 2003, p. 98)

The term "transit joint development" (TJD) has been added to the urban planning lexicon to describe the role of public-private partnerships in transit-oriented development (TOD) and TOD that is unique from other types of TOD. (Cervero R, 2008, p. 15).

TOD has expanded its reach throughout time by incorporating a range of typologies. Dittmar and Ohland described TOD communities as follows in their 2004 book "New Transit Towns": downtown urban, neighborhood urban , suburban town center, neighborhood suburban , transit-rich neighborhood, and commuter town (Hank Dittmar, 2004).

To better understand the concept, for the purpose of this research we will provide some widely encountered definitions categorized by year, to provide a collection of definitions that have positively contributed to this research. These definitions are only a few representing the components of TOD-s in literature and plans, we may refer to Table nr.12

It is difficult to develop a universal TOD concept since each location is unique in terms of character, usage, historical characteristics, and future improvements.

Table 12 Collection of definitions found in literature. Source: own elaboration

Authors	Definition	Year
Peter Calthorpe	TOD was suggested as a compact, mixed-use community that was based around a transit station to encourage residents, employees, and shoppers to drive their cars less and to use mass transit more	1993
Salvensen	Development around a transit station providing opportunities for a diversity of land uses in a specified geographical area, development within a specified geographical area around a transit station with a variety of land uses and a multiplicity of landowners	1996
Boarnet and Crane	The practice of developing or intensifying residential land use near rail stations	1998

Still	Mixed land use development encouraging people to live around the transit services, at the same time decreasing dependence on a private vehicle	2002
Cervero, R / Ferrell, C / Murphy, S	A transit-oriented development (TOD) system is mainly designed to enhance the use of public transport/transit and to create an urban setting providing pedestrian-friendly environment	2002
Tom Still, Zane Bishop, Hank Dittmar & Gloria Ohland, Carey Curtis, Peter Calthorpe	TOD promotes mixed use in buildings, high density and pedestrian- friendly development around transit to promote transit riding, increase walk and bicycle travel, and other alternatives to car use. Aims to promote development without adding to sprawl, freeing open space and adding public transportation	2003
Transit Oriented Development Institute	Transit Oriented Development (TOD) is a new concept focusing on efficient modes of transportation other than the automobile	2015
Transit Link network	TOD was defined as a combination of land use and transport planning that makes walking, cycling, and public transit use more convenient and attractive, while also optimizing the capacity of existing transit services by concentrating on transit hubs, and nodes	2012

As a result of our own realization, (keeping in mind that the definition we have considered, is linked closely to the objectives of this thesis, with a clear focus on TOD, mobility and transport) we will apply our own refinement of the definition as indicated below for the sake of this thesis:

“TOD is a model of development which relays on “A mixed-use community and transport planning”, aims to promote dense development, freeing open space and adding public transportation” **Author’s elaboration.**

Considering our quest, we must step away from the defining of the theory and view TOD as more complex theory. To classify TODs geographically, White and McDaniel published a 1999 paper in which they identified six types: single-use corridors (in the sense of transit corridors), mixed-use corridors, Neo-Traditional Development (development that adheres to new urbanism principles such as traditional urban layout and narrow streets), and Transit-Oriented Development: compact, mixed-use development centered on transit stations (White, 1999). In

addition to the "Hamlet or Village Concept," there is the "Purlieu Concept," which is around 150 acres in size and can accommodate 7,000 people while adhering to strict and rigorous design restrictions (White, 1999). When it comes to the proximity of transit-oriented development (TOD) investments, there are various classifications to consider: light rail stations, trolley stations, metro stations, busways (such as the BRT Curitiba in Brazil), and park-and-ride lots are just a few examples.

In order to be successful, TOD is reliant on the three Ds: density, diversity, and design . It is generally agreed that shared-ride services, public transit, and non-motorized modes of transportation are all connected to these three components of transportation. Furthermore, it is anticipated that these dimensions would improve public transit for both work and non-work-related trips. It is anticipated that a more compact site with close retail shops and a pleasant walking environment will encourage increased foot and bicycle travel, as well as short-hop transportation travels, for non-work-related excursions.

If a location is densely inhabited, multifunctional, and pedestrian-friendly, more people will use public transit than if it is isolated, single-purpose, and auto-oriented. The purpose of a railway station does not have to be restricted to serving as a point of departure and arrival; it can also serve as a point of entry for (Cervero R. , Land Use Mixing and Suburban Mobility, 1988). By emphasizing diverse activities in an otherwise repetitive location, TODs foster a vibrant and healthy living environment, active business districts, and bustling recreational zones.

The three Ds dictate TOD's efficiency, however wildly recognized there are five Ds in the concept of TOD. The five 'Ds' are frequently used as a framework for doing research on transit-oriented development. These three qualities are believed to be related to the usage of shared-ride, transit, and other non-motorized modes of transportation, as well as non-personal automobiles . These standards are expected to enhance public transportation for both business and leisure trips (Cervero R, 2008). For non-work-related excursions, a more compact site with close retail establishments and a pleasant walking environment is projected to

stimulate more foot and bicycle commuting, as well as short-hop transportation journeys . People are more likely to use public transportation in dense, pedestrian-friendly urban areas than in auto-oriented suburban areas . (Cervero R. , Land Use Mixing and Suburban Mobility, 1988).

The five (density, diversity, design, distance to transit, and destination accessibility) are widely acknowledged as important to the success of a TOD (Ewing R. &., 2010).

When we talk about "diversity," we're talking about how many diverse land uses coexist in one area. Various land uses can be found. Comparisons are made between various levels of land use and other elements, such as transportation utilization, in order to simplify the process. Once the categories and values have been selected, the elasticity between them may be calculated (Cervero, Ferrell, & Murphy, Transit-Oriented Development and Joint Development in the United States:A Literature Review, 2002).

Design. We're talking to the roadway layout in this case. Straight streets in the city's core are linked to curved streets and cul-de-sacs in the surrounding suburbs by a street network. The number of intersections per square meter of land, the number of four-way intersections, and the block size are also included. Non-sidewalk elements of urban planning include building setbacks and highway width (Cervero, Ferrell, & Murphy, Transit-Oriented Development and Joint Development in the United States:A Literature Review, 2002).

Here, we're discussing how to go to various destinations. In other words, the closeness of the place to well-known landmarks is a consideration. It is permissible to go to local and regional places. Regional accessibility may be measured in two ways: distance to the city's center or job prospects within a specified time range. If you're close to the city center, getting to your locations will be straightforward. Local accessibility refers to the number of businesses and services located within a certain radius of a person's house.

TOD is an abbreviation for a comprehensive approach to transportation and land use planning . A sometimes overlooked but crucial component of TOD theory is pedestrian access between transportation stations and their immediate surroundings (M. Venner, 2007). The ultimate purpose of urban and transportation planning is to improve the quality of life for its inhabitants . Planners must thus strive for sustainability in order to meet the quality-of-life expectations of present and future generations .

4.4 Understanding TOD

TOD was meant to be a compact, mixed-use hamlet centered on a transit station in order to encourage more regular use of public transportation . By concentrating on transit hubs and nodes, TOD strives to improve inhabitants' and visitors' quality of life by making it easier to travel by foot, bicycle, or public transportation (Joshi, Joseph, Patel, & Darji, 2017).

TOD may be used in a number of ways to promote economic development and smart growth. Together with alternate modes of transportation, accessible housing, and the potential of improved income, TOD promotes a healthy lifestyle (Joshi, Joseph, Patel, & Darji, 2017).

Furthermore, TOD reduces dependency on non-renewable energy sources and conserves open space. This may be done through the use of life-cycle energy to reduce CO2 emissions, greenhouse gas production, pollution, and respiratory concerns linked with smart development. Location efficiency, option diversity, value recovery, place development, and node-place conflict resolution are among the five fundamental goals of an effective TOD (Brinklow, 2010).
Establishing transit stations as community hubs can help to increase the variety of a city's residents. Shared spaces or open places might be used. There has to be a physical linkage between the current neighborhoods and centers. Transportation-Oriented Development, or TOD, is a wide phrase that refers to anything from urban densification to increasing public transit use and fostering smart growth (Cervero,

Ferrell, & Murphy, Transit-Oriented Development and Joint Development in the United States:A Literature Review, 2002).

TOD initiatives are promoted globally as viable alternatives for increasing transit use and reducing automobile use while simultaneously supporting local development and improving the quality of life in formerly deprived places . TOD is a kind of urban construction that encloses a public transit station in a mixed-use, pedestrian-friendly, densely built neighborhood (Litman, 2017). Given that TOD is a complicated policy concept requiring the involvement of various stakeholders and levels of government over an extended period of time, we challenge the transferability of TOD theory and practice“.

To measure the effect of urban design modifications on travel behavior, simulation studies employ fictitious communities and a forecasting model of travel demand. One may argue that the Netherlands adopted TOD long ago: cities are compact, with dense cycling and public transportation networks, and the country is served by a massive rail network. Despite this, urban districts based on TOD principles, which have gained popularity in Asia, Western Europe, and North America over the last several decades, continue to face significant difficulties . Several of the definitions in the table below can assist us in developing a fundamental knowledge of TOD and the relationship between TOD, land use, and transportation .

Transit-oriented development is complicated by the conflict between practical and idealistic goals. In addition to normative ideas like livability, variety and livability, walkability, density, and site efficiency are included in many TOD definitions (Cervero R, 2008), (Dittmar H. G., 2003). Mixed-use complexes with a reasonable density, optimal gradient, and an emphasis on (and walking distance from) public transit hubs are at the heart of these TOD guidelines. It is becoming increasingly difficult to maintain our current way of life on a limited planet at the rate at which it is already occurring (such as land and fossil fuels) (Ewing R. H., 2017). Integration of land use and transportation planning is also becoming more critical, particularly as cities expand (Bernick M, 1997).

Additionally, an increased emphasis is being placed on integrated land use and transportation planning, with an emphasis on sustainable mobility and urban expansion (Banister D. , 2018). As a result, these plans place a strong emphasis on land use and transportation integration, underscoring the critical relationship between transportation networks and land use patterns (Brotchie, 1995).

A transit-oriented development (TOD) is more than just a transit stop; it is also a shopping, dining, and social destination. In addition to serving as a focal point for social interaction, it also provides a setting for urban growth to take on a more dispersed but yet focused shape (Thomas & Bertolini, 2020). Researchers are increasingly realizing that TODs come in a range of shapes and sizes, and that each TOD serves a separate but complimentary role in a system, according to the latest findings. For regional construction, they proposed the following variations on TOD design: city center, activity center, specialized activity center, and TODs throughout the city and its surrounding suburbs as well as in the neighborhood (Joshi, Joseph, Patel, & Darji, 2017).

Calthorpe divides TODs into three categories based on the size of the area served: Neighborhood TODs serve a specific neighborhood within a community, whereas Regional TODs cover an entire region . With a focus on Neighborhood TODs, the emphasis is on residential use, with locally targeted commerce in facilities sized to serve the surrounding population as a secondary benefit (Calthorpe, 1993).

While this research recognizes prior debates about whether or not to embrace TOD, it focuses on how TOD may be implemented, if desired, and what characteristics and circumstances contribute to its effectiveness.

4.5 The context of TOD

Peter Calthorpe was the first to use the term "Transit-Oriented Development" in the late 1980s, even though others had campaigned for similar ideas and contributed to the design. With the publication of Calthorpe's "The New American Metropolis"

in 1993, TOD became engrained in contemporary planning (Calthorpe, 1993). To phrase differently, a TOD is a mixed-use area designed to encourage people to use public transportation instead of driving everywhere. According to Calthorpe, it serves as an excellent guide to fostering sustainable communities. Additionally, it was a community design philosophy that attempted to alleviate a wide range of societal problems in addition to its conception of constructed form (Bertolini, 2007, p. 62). Calthorpe, a student of environmental sustainability, devised TOD to solve community ecology issues. TOD was also a simple answer for the prosperity of the region, according to him.

TOD strives to achieve a number of interconnected goals for a number of different user segments. Areas for people to live, work, shop, and rest should be included in TODs in the best-case scenario . People with low or moderate incomes are more likely to appreciate transit access and to own fewer cars and live in more space-efficient buildings, allowing them to fully benefit from TOD's proximity to public transportation .

Numerous cities throughout the world have prioritized transit-oriented development. With a focus on transportation and urban development (TOD) under the umbrella, the concept appears simple at first glance (Dittmar H. G., 2003).
The simplicity of the concept stands beyond the concentration of development around stations and nodes. However different, the context in which this concept is materialized, the argument of increased accessibility takes priority to the automobile-based alternative. (Bertolini, 2007) The proposal attempts to expand today's transportation options, nearly approaching the urban quality of life metric, which in a TOD reality is virtually compelled to interact, in contrast to the separated private "my vehicle" urban setting.

The contradiction between "fast or speedy" transportation principles and sluggish but accessible nodes is a major idea in transit-oriented planning. A successful TOD would adhere to these standards in the face of high-density expansion and short distances between nodes (Curtis, 2009).

TOD is a vital part of both smart development and modern urbanism since it prioritizes local livability and minimizes transportation footprints. Promoting both a reduction in reliance on automobiles and, as a subject of dispute, a social cost-benefit analysis and sustainable answers to the segregated border (considering the impact that this theory has on the real estate market and value) (M. Padeiro, 2019).

4.6 The shift of TOD

Environmentalists, public health experts, economic development agents, real estate agents, and regional transportation officials all favor TOD as a design idea for their projects. Cities and counties (as well as a substantial section of the voters) believe that rail transit is essential to reducing congestion, reshaping urban form, making the city more livable for its residents, and attracting economic growth" (Schuetz, 2018)

Not only do well-designed TODs enhance ridership by attracting more visitors away from their automobiles and onto trains and buses, but they can also act as catalysts for community growth and revitalization in troubled metropolitan areas. (Cervero R. G., 2017). The world's greatest TODs act as focal points for revitalizing, enriching, and invigorating local communities (Cervero R. G., 2017). Frequently, the process of identifying the future use of transit station spaces begins with the development of a TOD typology. Land usage can be used to categorize TODs.

Green TOD is gaining traction in a number of regions as an ultra–environmentally friendly variation of TOD. Green TOD is a blend of transit-oriented development and sustainable urbanization (Cervero R. G., 2017). The combination has the potential to generate synergies that result in environmental advantages greater than the total of what TOD and green urbanism provide separately . Pocket parks and community gardens are used in place of surface parking in green urbanism (Cervero R. G., 2017).

When TOD and green urbanism are integrated, energy independence, waste-free living, and sustainable mobility are possible. Transit corridors are natural

ecosystems that can be incorporated into existing infrastructure to promote accessibility and placemaking (Cervero R. G., 2017). Stations and their environs provide great catchment areas for residential and commercial development, and under the appropriate circumstances, they can act as community anchors.

4.7 Mitigating the problems associated with Sprawl

Transportation developments, in theory, have an impact on where land development takes place by boosting accessibility to certain places at the expense of others. In a similar vein, the location of expansion determines the types of transportation improvements that will be necessary to meet the accessibility and mobility requirements of the population (Atash, 1996).

Since the early 1990s, transit-oriented development (TOD) has been widely acknowledged as a method of reducing urban sprawl throughout the world. Transportation as a mode of transportation (TOD) has been hailed as a viable solution to the problem of automobile-driven urban sprawl, which is exacerbated by factors like as poor accessibility and a lack of open space (Ewing R. H., 2008).

First and foremost, there is the issue of size when it comes to urban sprawl. Distinguishing between dispersed and polycentric (also known as multinucleated) development is perfectly acceptable. "It's not clear where polycentrism ends and sprawl starts," states Gordon and Wong in the 1985 publication (Gordon, 1985, p. 662) The term "sprawl" refers to the spread of development, which is wasteful in terms of infrastructure, public service, and personal transport.

What distinguishes sprawl from other growth patterns is the lack of connectivity between related land uses. We really in literature find references to sprawl and poor infrastructure, however mostly any type of sprawl is characterized by poor connectivity ad infrastructure as stated by Ewing R in this literature review on effects of sprawl, (Ewing R. H., 2008). Growing incomes, technological advances, low travel costs, and high travel speeds all contribute to the "natural" development of low-density suburbs in the United States.

This demonstrates that sprawl can be defined broadly as any expansion pattern that generates inaccessibility between land uses that are closely connected. Inaccessible places may be the result of a failure to concentrate growth and/or mix land uses, or they may be the result of poor planning (Ewing R. H., 2008).

Suzuki. H states that overall, TOD sought to promote sustainable development by minimizing environmental and social concerns associated with automobile-driven urban sprawl, such as traffic congestion and air pollution (Suzuki, 2013). A fundamental premise of TOD advocacy was that urban sprawl mitigation was a viable strategy for achieving long-term development (Suzuki, 2013).

Land-use patterns that are considered 'undesirable' are commonly used to describe sprawl (Hayden, 2004). Ewing identified density, mixed use, activity concentration, and street accessibility as four indices for quantifying sprawl, establishing it as a multidimensional term encompassing both form and function (Ewing R. H., 2008).

After the WWII the concept of TOD has become present in many cities, the objectives of this theory make it easy for this concept to position itself in in sprawl mitigation. As the theory advocated for mixed use and proximity to transit, theoretically disregarding the use of the car (Ewing R. H., 2008). However, some doubt about the mitigation of sprawl is related to the first inspiration of the theory, “the garden city” were at the western hemisphere's industrial revolution's height, it was a decentralization strategy for dealing with the congested and disorganized metropolitan core (Hall P. , 1988).

Due to the close relationship between land use and transportation, planners must take caution while regulating land development to avoid hastening the decentralization of jobs and housing. On the other hand, a limited correlation between development and placement choices is dominated by sociodemographic and neighborhood and community features. When the connectivity is poor, urban policies that rely on it will produce disappointing commuting results (Bernick, 1997).

4.8 The Typology of TOD

The growing issue of cities expansion, growth and densification has prompted considerable concern about the techniques that can help cities manage development. Transit oriented Development, Focuses on the integration of land-use with transit needs (Banister D. , 2018).

A TOD is often defined as a mixed-use development that is located close to or adjacent to public transportation options. Among the characteristics of TOD include urban density, pedestrian and bicycle-friendly corridors, public spaces near to train station entrances, and train stations built to serve as gathering places.

A TOD categorization is essentially a collection of station areas. They share similar morphological and functional properties, Calthorpe, as the first to define TODs, in his book “The Next American Metropolis” identifies two types of TODs, the “urban TOD” and the “neighborhood TOD”. They are distinguished by the spatial orientation of the area and services (Calthorpe, 1993).
Researchers are increasingly discovering that TOD can take on a number of shapes and that unique station regions can perform distinct but complementary duties within a system organization (Calthorpe, 1993).

Dittmar defined TOD into six distinct typologies based on their context: urban downtown, urban neighborhood, suburban town center, suburban neighborhood, neighborhood transit zone, and commuter town (Dittmar H. P., 2004). As illustrated in table nr. 3 Dittmar, defined typology’s according to their context characteristics

Table 3 New Transit Town, Dittmar and Ohland 2004, Typology definitions / Author’s collection and table index qualification

TOD Type	Land–use mix	Minimum housing density	Housing types	Scale	Regional connectivity	Transit modes	Transit frequencies	Examples
Urban downtown	Primary office center, urban entertainment, multifamily housing, retail	>60 units/acre (> 148 units/ha)	Multifamily loft	High	High Hub of radial system	All modes	< 10 minutes	Printer’s row (Chicago), LoDo (Denver), South Beach (San Francisco)
Urban neighborhood	Residential, retail, Class B commercial	> 20 units/acre (> 50 units/ha)	Multifamily Loft Townhome Single family	Medium	Medium access to downtown subregional circulation	Light–rail Streetcar Rapid bus Local bus	10 minutes peak 20 minutes off peak	Mockingbird (Dallas), Fullerton (Chicago), Barrio Logan (San

Sub urban center	Primary office center, urban entertainment, multifamily housing, retail	> 50 units/acre (> 124 units/ha)	Multifamily Loft Townhome	High	High access to downtown subregional hub	Rail Streetcar Rapid Bus Local bus Paratransit	10 minutes peak 10-15 minutes off-peak	
Suburban neighbourhood	Residential neighbourhood, retail, local office	> 12 units/acre (> 30 units/ha)	Multifamily Townhome Single family	Moderate	Medium access to suburban center Access to downtown	Light-rail Rapid bus Local bus Paratransit	20 minutes peak 30 minutes offpeak	Crossings (Mountain View, CA), Ohlone–Chynoweth (San Jose, CA)
Neighbourhood transit zone	Residential neighbourhood, retail	> 7 units/acre (> 17 units/ha)	Townhome Single family	Low access to a centre	Low	Local bus Paratransit	25-30 minutes demand responsive	
Commuter town center	Retail center, Residential	> 12 units/acre (> 30 units/ha)	Multifamily Townhome Single family	Low	Low access to downtown	Commuter rail Rapid bus	Peak service Demand responsive	Prairie Crossing (Illinois), Suisun City (CA)

TODs are classified as follows: (1) new towns developed around new public transportation services; (2) high-density TODs in which new public transportation services are integrated into existing, compact, mixed-use areas; and (3) low-density TODs that increase the density and diversity of existing, suburban-style neighborhoods adjacent to public transportation services (DeVos, Van Acker, & Witlox,2014).

Prior to the 1990's, TODs were considered as a form of successful real estate development, used to generate revenue for transit agencies and the government, and evaluated only on the basis of financial viability, rather than on the basis of sustainable transportation principles.

Planners now universally recognize that newly planned development requires both a reduction in total car use and a concentration of urban movement patterns around single Central Business Districts (CBD).

Transit-oriented development is defined in layman's terms as planned mixed-use development based on a large public transportation hub.

Mixed-use developments near or beside public transportation are sometimes referred to as TOD. In order to be classified as TOD, an area must have a high density of people, pedestrian and bicycle-friendly corridors, public spaces around stations, and stations that act as community hubs (TCRP, 2002). First, new towns centered on new public transportation are called TODs, while second are called

"high-density TODs," and third are "low-density TODs," which increase the density and diversity of existing suburban-style neighborhoods adjacent to public transportation services through the integration of new transit services into existing, compact, mixed-use areas" (DeVos, Van Acker, & Witlox,2014). Beyond the confines of train stations, TOD plans aim to transform entire metropolitan areas in Asia, North America, and Europe around rail transit (Knowles,2012; TransLink,2012).

Initially, TODs were envisioned as successful real estate assets that benefited transit agencies and the government. In the end, they were judged exclusively on the basis of their financial viability, rather than on the principles of environmentally sound transportation.

Planners believe that new building should limit the amount of car use and the concentration of urban movement patterns in a few Central Business Districts, a fact that the public has increasingly acknowledged (CBD).

A planned mixed-use neighborhood near a major public transportation hub is referred to as a transit-oriented development (TOD).

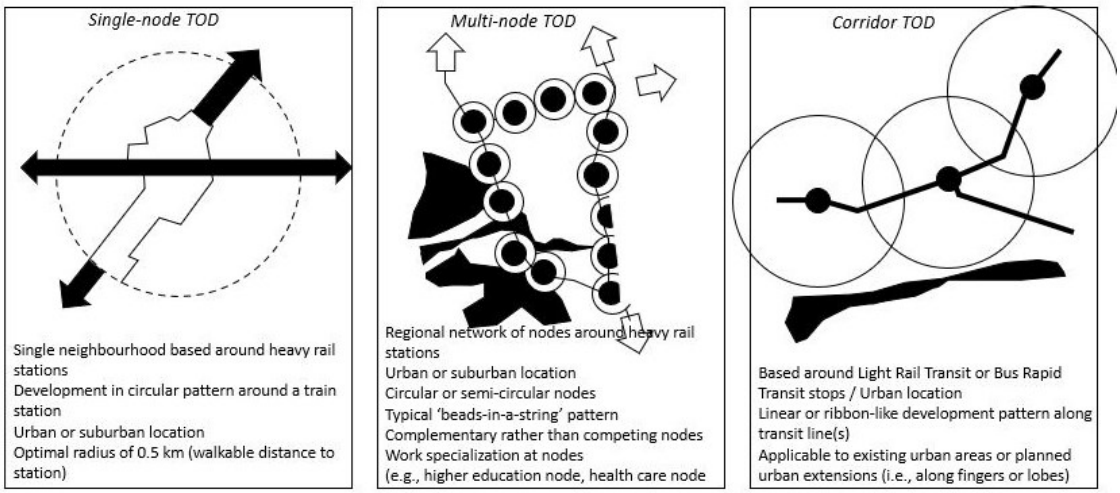


Figure 13 The Typologies of TOD, a comparative typology selection between the case studies and the classic typology/ authors personal library

When it comes to developing TODs, the underlying premise remains unchanged, yet each TOD has its own unique set of traits. The size of the TOD will be determined by the amount of land that is available and dedicated to this purpose.

A large commercial and office or employment area is supported by urban TODs, as well as a higher density of residential uses, than is the case with rural TODs.

TODs with a minimum density of 30 dwelling units per net hectare and an average density of 45 dwelling units per net hectare are typically found in metropolitan areas; in rural areas, the minimum density is 17 dwelling units per net hectare and the average density is 25 dwelling units per net hectare (Calthorpe, 1993; Gatzlaff et al., 1999). Based on distinctions in locales and destinations within regions, the TOD typology is created, as shown on Table nr. 13, to characterize distinctive TODs at various levels. The most relevant performance measurements and descriptive metrics standards are then identified. The location, size, and route of transportation of TODs are used to classify them.

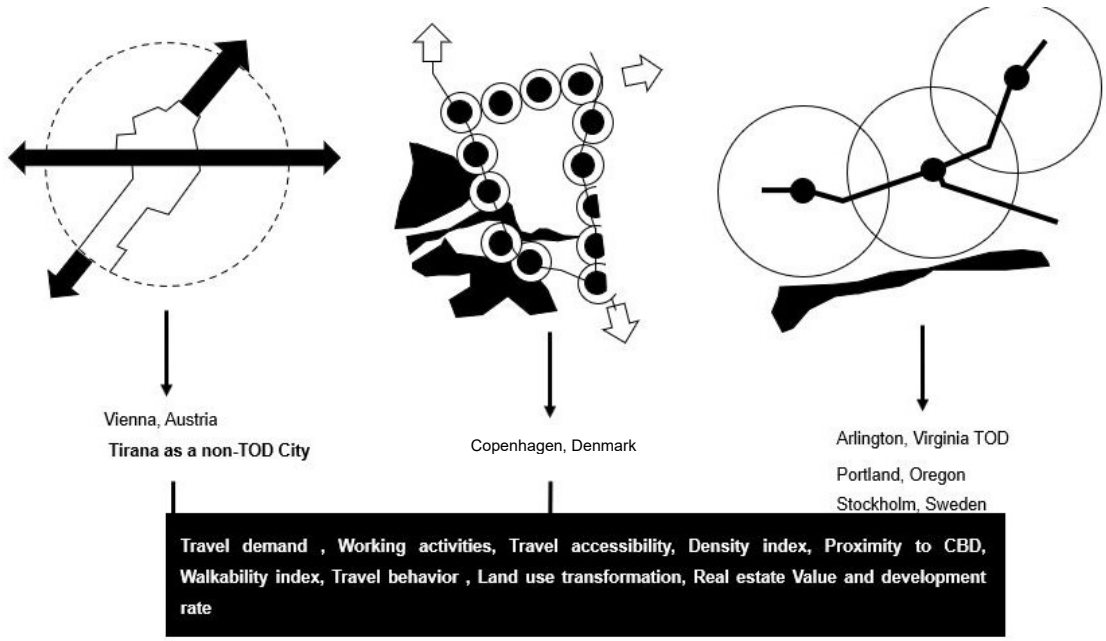


Figure 14 The Typologies of TOD, a comparative typology selection and sub components between the case studies and the classic typology/ authors personal library

4.9 The components of TOD

Developing under the TOD “wing” to support urban challenges is now a common practice. As a tool to address key challenges such as increased transit ridership, sprawl, accesses to service, a number of authors have attempted to translate the main components of TOD development.

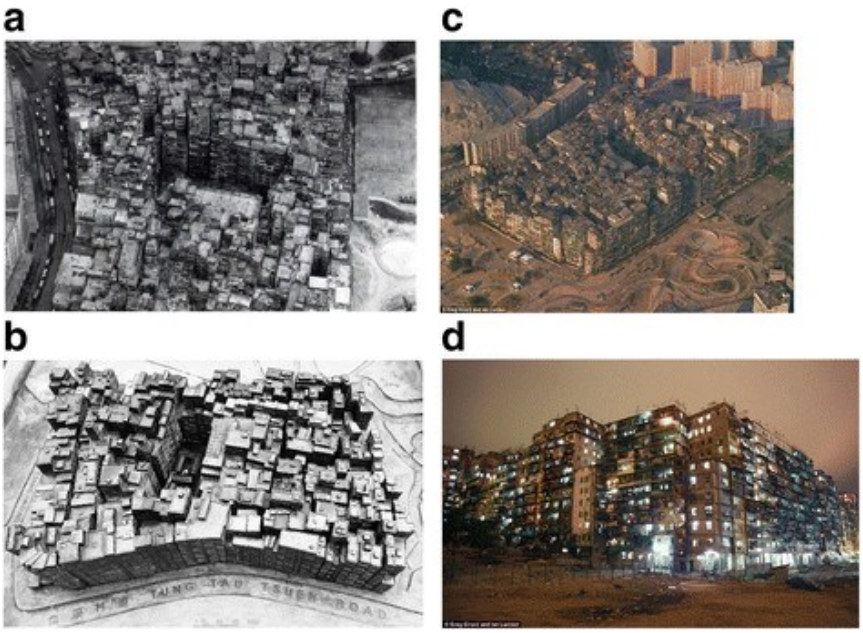
4.9.1 Density

At first glance, density looks to be an excellent idea for planners because it is objective, quantifiable, and neutral. Churchman (Churchman, 1999) Urban density refers to the proportion of a city's total population to its total area. One of the most important aspects of a TOD's success is density (Curtis et al. 2009). "Density is a crucial predictor of modal choice: high densities are linked to shorter average travel distances across all modes" (Holtzclaw 1994; Hollevoet et al. 2011).

This is the most useful single metric for tracking urbanization progress, and it is currently a top priority on the global climate change agenda. Urban density, or, more precisely, urban population density, is defined as "the ratio of the total number of people living inside a well-defined footprint of a city to the total area of that footprint." Densification, or the process of increasing urban density, has long been recognized as a good environmental goal. For starters, urban density translates population into land consumption: a city with a given population will have a smaller geographic footprint, requiring less conversion of the surrounding countryside to urban use. Second, people in a city with a larger population density will be closer to one another. Queen Elizabeth I issued a proclamation in 1592 to control London's growth, but it was unsuccessful. Green belts and urban growth borders, as well as the construction of new and satellite towns, have all been employed to help decongest core metropolitan regions and absorb population growth.

Three phrases are used to describe density and how it affects people's lives: density, perceived density, and crowding (Alexander, 1993). The link between a physical location and the number of people who reside in or use it is referred to as "density." It's determined as a ratio of population size to area units (the numerator) (the denominator). It's neutral in the sense that determining whether a density level is positive or negative is impossible right away (Churchman, 1999).

Spatial density is defined as the number of people in a given space of varying sizes. The premise behind perceived density and crowding is that the same density can be experienced and judged differently by different people, in different settings, and across cultures and countries. A person's perception and estimate of the number of people in a given place, the available space, and the organization of that space is known as perceived density. An individual's subjective evaluation that a certain density and perceived density is unfavorable is characterized as crowding. Density may appear to be an unproblematic objective and quantitative term, but this is not the case because there is no globally accepted density metric that can be used to compare countries or even metropolitan areas. (1993, Alexander) The term "urban density" refers to the dimensions of interactions between urban substance and existence characteristics such as the number of homes or inhabitants per hectare. The evaluation of numerous characteristics of urban density gives important information for city planning, development, and management." Given that urban density is heavily influenced by its surroundings, the "good" and "bad" of urban density is linked to a wide range of indices, both vertical and horizontal. (National Board of Housing of Sweden, 2017) Due to its great density and poor living conditions, the Kowloon Walled City in Hong Kong was dismantled in 1992-93. All that remains of the Hong Kong mythology today is a bronze recreation of Kowloon Walled City in the midst of a public park where it once existed. With a population of approximately 50,000 inhabitants, the Kowloon Walled City was a densely packed superblock. The Kowloon Walled City in Hong Kong was one of the city's and the world's densest self-built structures for the Chinese people until 1994.



Kowloon Walled City in Hong Kong; it earned its Cantonese nickname 'City of Darkness' (photo around 1989)

"The Kowloon Walled City is, in many ways, a microcosm of Hong Kong's metropolitan environment." "The Kowloon Walled City demonstrates that a high-rise, high-density urban environment as extreme and unconventional as itself need not be harsh and uncomfortable, but may be a vibrant and highly livable city." "The citizens of Hong Kong's refusal to accept the drawbacks of living in a crowded and congested environment is largely responsible for the city's prosperity" (Greg Girard, 1993).

4.9.2 Walkability

Walkability refers to a person's ability to traverse a place on foot. A pedestrian is someone who prefers to walk to driving. As a result, walking is now considered a mode of mobility on par with driving, cycling, and using the train. This lack of focus on pedestrian planning indicates that it is either not regarded as a critical component of the transportation system, or that it is deemed unimportant enough to justify major research, planning, and design costs.

In the post-modernist planning era, walkability has only recently been acknowledged as a critical component of efficient, accessible, equitable, sustainable, and livable communities. In the debate over urban planning, walkability metrics that consider the physical environment at a finer level are explored. Despite the fact that little effort has been put into understanding how to maximize pedestrian areas, how we define walkability has significant implications for our understanding and design of urban transit networks and public spaces (Lo, 2009).

Some walkability concerns focus on the means or conditions that allow walking, such as traversable, compact, physically appealing, or safe locales. Others say that walkability refers to the impacts or outcomes of such walkable environments, such as making places livelier and more convivial, enhancing transportation options, or encouraging physical activity. The term "walkable" has been used since at least the eighteenth century (Oxford English Dictionary,2014). On the other hand, walkability

is a more recent term that is rarely defined in dictionaries but is commonly used. Finally, walkability is frequently used as a proxy for better urban planning that is more pedestrian-friendly. The demand for knowledge about the built environment's walkability is growing. Urban planning, design, and transportation research have all looked into the benefits of walking in the city (Gehl, 1987).

There's also "walkability" research, which is a collaborative kind of research that began in the preventive medicine field and focuses on the health advantages of walking. Walkability studies have revealed evidence that individuals' walking behavior is related to the state of the urban form through statistical analysis of the amount of time spent walking and features of the built environment. Previous findings from transportation and urban planning research, as well as current walkability studies, have identified some important features of urban form walkability, such as density, connectivity, and land use.

Previous research has shown that physical activity and the presence of various land uses have a positive relationship. While 'walkability' studies frequently measure and analyze walking by the amount of time spent walking by individuals, urban design research on pedestrian movement often takes an empirical-quantitative approach that focuses on collective patterns of behavior and their relationship to the physical environment. Most urban planning and design research that investigates walking in the urban environment, sometimes lumped under the label "walking" or pedestrian mobility, has considered walking behavior as a fairly simplistic concept.

Among other things, walking activities differ in terms of effort, goal, efficiency, frequency, continuity, intensity, and duration. Recent walkability research has underlined the need of knowing these distinctions in order to better understand how the built environment might encourage walking (Rodriguez, 2006). (Land Use Mixing and Suburban Mobility, p. 125)

4.9.3 Public transport

In terms of the physical road, thoughts about urban circulation and transportation are linked to acts that are analogous. The impact of historical accessibility and road networks on the evolution of transportation and circulation systems is investigated. The supply-demand analysis for urban transportation is preserved, as are the forms of urban transportation and the agents who provide it, as well as rural and urban transportation networks.

In order to show transportation economics, as well as future roles and advancements in the transportation sector, urban land use, function allocation in urban land, and matching activity patterns are all linked to circulation-access patterns. The official global core indicator for SDGs is the percentage of the population who lives within 500 meters of a public transportation stop (which equates to a walking distance of around 5 minutes). While this metric is useful as a worldwide benchmark, it will fall short of indicating how urban public transit is 'expanding,' as the SDGs aim. Cities may find indicators valuable in analyzing their needs and performance, which is necessary for developing new financing possibilities.

Rather than national or international standards, these are usually neighborhood-level assessments of the quality of pedestrian and public transportation infrastructure. When practicable, the quality measurements have used a "traffic light" (Red-Yellow-Green) value grading scheme to keep the system as practical and cost-effective as possible.

Existing metrics and standards should be used whenever possible to create more uniformity (UITP, 2019). Cities and metropolitan regions can use indicators of sustainable urban mobility to evaluate the strengths and weaknesses of their transportation systems, as well as focus on areas that need to be addressed.

As cities and urban regions continue to develop Sustainable Urban Mobility Plans (SUMPs) and work toward reaching EU policy goals, it is vital that their progress be documented so that their achievements can be acknowledged. As a result of differences in socioeconomic, cultural, historical, and environmental factors, urban areas in different regions have varying shapes and characterizations, and urban growth patterns are diverse.

Individuals in the United States, for example, choose to live in single-family houses with minimal density and drive to work. The Japanese landscape, on the other hand, is dominated by high-rise residential structures, with employees using public transportation" (Yamagata, 2014). Understanding how cities are shaped by setting the appropriate transport priorities can aid in the achievement of sustainable mobility objectives; and understanding how cities are shaped by setting the appropriate transport priorities can aid in the achievement of sustainable mobility objectives.

Because transportation networks are such important components of urban settings, ensuring their long-term viability is crucial to achieving complex urban sustainability. Despite the fact that no comprehensive and widely accepted definitions of urban sustainability or sustainable transportation exist, the assessment of urban sustainability is presently a hot topic in a range of scientific areas. The first step in identifying the major challenges, roadblocks, and intervention areas in the city transportation sector is to define what sustainable urban transportation entails (Buzási, 2015).

4.9.4 Mix-use

Traditional urban spatial structure economic theory predicts that urban land cover will expand as a function of population and prosperity, as well as as a result of lower transportation costs (S . Angel, 2011). Mixed-use buildings are structures that serve three or more purposes, such as residences, hotels, retail establishments, parking spaces, transit hubs, and cultural and entertainment venues. Whatever the combination, it brings a wide range of uses together in a single structure or confined

space. Residences on the upper floors with retail or office space on the ground floor are a frequent combination because it is a single, multi-story construction." On the basement level, there is parking and/or connection to subterranean public transportation.

Horizontal. These discrete structures, which are scattered throughout a number of buildings, such as a city block or around an open space or courtyard, fulfill one or two distinct tasks while providing a microcosm inside a community. As the urban population grows, there is a greater demand for structures that can "do more with less." A good mixed-use complex design, on the other hand, requires more than simply cramming as much as possible into a single structure.

TOD must take into account the needs of future residents, as well as the impact on the surrounding community and the potential advantages to the community.

A structure with many purposes that responds to the demands of its environment helps to generate unique neighborhoods by allowing people to live in multiple areas. Despite the fact that mixed-use structures are environmentally friendly, they also have other advantages beyond resource conservation. They assist us in rethinking how cities may be built in such a way that urbanization becomes an advantage rather than a hindrance to our lives. Houses, stores, restaurants, cultural centers, institutions, and manufacturing facilities, all of which are physically integrated in varied sizes, intensities, and combinations, make up mixed-use zones in their broadest sense.

People can coexist in one spot while working, relaxing, or shopping; this site then becomes a vital activity destination for people from other places, improving economic viability and space security by increasing the number of people on the street and in public places." Multi-function areas and spaces are based on the principle of making efficient use of urban areas and infrastructure. This is accomplished by bringing everything people need as close as possible to their houses. The division of functions into quarters and districts will help to promote and maintain economic prosperity.

This strategy saves a lot of space while also addressing the increased demand for residences in the city center and accommodations near places of work (Vorontsova, 2016).

4.9.5 Proximity

Access to public and human services when they are needed is critical for population health and well-being, as well as for communities to function well. The law establishes proximity standards that are distinctive to each country. Things like schools, healthcare facilities, and so on (Urban Journal for future cities). Get close to what you're seeking for, or anything you require. Planners must create mixed land use zones to ensure that people may easily obtain the commodities they require on a regular basis (shops, schools, health care, employment etc.).

This eliminates the need for travel and promotes the growth of vibrant, diverse communities in the immediate vicinity (Dena Kasraian, 2019). Transportation and land use planning are the ultimate facilitators of closeness. Our urban layout, which includes density, permitted uses, and transit systems, can either help or hinder economic development. Despite the best efforts of many corporate and civic leaders, the United States' current transportation paradigm places much too much attention on traffic and far too little on distance.

In each case, the goal was to be physically close. In the era of strolling, biking, and shared carriage or streetcar rides, clustered buildings and roadways helped connect as many regions as possible over short distances. Prioritizing human scale proximity and the reduction in travel time that results. As a result, short-distance travel benefits from an urban design that promotes it.

- Proximity has a contagious effect by stimulating agglomeration and the expansion of local businesses and economies. People and businesses clustering close together (or clustering) benefit urban economies because it lowers commuting time and fosters information sharing. Cities

and suburbs that encourage intimacy, such as dense, diverse, and pedestrian-friendly neighborhoods, can help to promote agglomeration.

- When people are closer together, the financial duties of the community are lowered. When cities and suburbs use less land, they require less infrastructure—not only roads, but also water pipes, broadband networks, and electrical lines—to function. This lowers the cost of building and maintaining the initial infrastructure for taxpayers.

- It's easier to get around when you're near to your destination. Individuals and places that are closer to one another are more likely to consider walking, biking, or taking a specific mode of transportation. Households will be able to save money by encouraging more people to walk, cycle, or take public transportation instead of driving. Increased proximity between people and venues benefits people of all ages, especially those who cannot drive.

- The importance of proximity in attaining carbon reduction targets and establishing more resilient communities cannot be overstated. Personal automobiles are the principal source of pollution in the transportation business, which is currently the most polluting. Because proximity stimulates non-driving demand, more non-driving travels will lead to cleaner transportation. While sprawl has its own set of environmental costs, such as higher per capita stormwater runoff and energy use, it also has its own set of disadvantages (Bank, 2019).

4.9.6 Scale of implementation

If cities are to remain successful, they must adapt and change to better manage their resources, infrastructure, and human capital. This is the essence of the term "futureproofing." Future-proofing cities entails enhancing and expanding a city's ability to respond to the hazards and challenges of the twenty-first century and beyond. (2018, Green)

A one-size-fits-all approach to building thriving societies is not required. In the Portland region, the 12-mile area surrounding fixed-guideway stations contains a diverse mix of intensities and land uses. Many of the station's zones are used largely for research and development," while others are more residential and low-intensity, while yet others are more job-oriented and high-intensity. As a result, pedestrian-friendly development that integrates two or more residential, commercial, cultural, institutional, and/or industrial uses is characterized as a type of TOD spending required in mixed-use construction. Mixed use is one of the eleven concepts of Smart Growth (Wagner, 2014).

Every building will be a city within a city, providing residents with all of the services they require without having to leave the building. The nature of urban planning and land use in this study was intertwined. To analyze the physical consequences of planning implementation, planning control indices and landscape metrics were devised, and fundamental causes leading to the disparity between intended and actual outcomes were explored (Eizenberg, 2019).

4.9.7 Security

Understanding urban security necessitates first tracing the semantic boundaries of the world we want to communicate before moving on to the physical ones. From a social science perspective, the first question to consider is what it means to be secure. The state's coercive authority was also delegated to the police and armed forces, who were in charge of maintaining domestic and international order.
The second preliminary question is what it means to talk about urban security in the present era, given the city's growing political role. From prehistoric sieges to the medieval period to the World War I terrorist attacks, cities have long been regarded as battlegrounds (Graham, 2004). Since the eighteenth century, an individual's sense of community has been best expressed by referring to themselves as a country.

We were able to draw a line between the legitimate space within a sovereign authority and the legitimate space outside of a sovereign authority by employing this concept." Graham, Stephen (2001). The same mentality that led to the establishment of defensive regions in urban planning, as well as the speculative real estate repercussions, spurred the gated community craze. The majority of urban police approaches rely on taking advantage of the vast new possibilities given by the development of Information and Communication Technology (ICT) 'Armao, 2016'.

Several elements, "some of which are related to urban design, have an impact on the degree of real or perceived security in a given area at the local level," according to the report. "Urban planning shapes the spatial architecture of cities, which has a direct impact on social segregation and residents' sense of urban security." "Several studies have found that how public spaces are planned, built, and maintained has an impact on people's feelings of insecurity." "Securing public spaces by design" is another title for this method, in which security features are considered from the start of the design process, taking into account the openness and interaction of the area with the surrounding urban environment (Tulumello, 207). Because of the tripartite structure of urban security (or community security), it is a political issue rather than a "social problem" that can be addressed objectively.

4.9.8 The Translation of Components

This section will look at how the TOD's primary components are reflected in our case studies, taking into account the component as well as the environment in which it is used. According to this study, which focuses on the transmission of ideas and practices between components, translation is crucial for understanding how change occurs. When an idea is transported and transformed at the same time, it is called translation. As a result, the transmission of a notion does not follow a linear diffusion model, but rather is changed into numerous meanings and articulated in a non-linear manner across documents and local activities. TOD is viewed as a collection of interconnected components that function and integrate in a variety of

sizes. The goal of this study is to look into the widespread effect of western urban planning concepts in non-western settings. The theoretical inquiry that took part in the Second chapter where we focused on the understanding of the urban dilemma and how urban theories influence the development of the city. The transition of the third and fourth chapter gave this research a deeper understanding of the concept of Tod and helped identifying the components of TOD, their application and what evolution of these components has in store for the possible adaptation of Transit oriented development theory into different context. This study contributes to the subject of TOD by conducting a comprehensive comparative analysis of the urban design characteristics of several TOD projects.

The clear emerging of the components, were translated by creating a matrix of the case studies and definitions of the concept, in correlation to the theoretical inquiry that took part in the beginning of this thesis. The eighth chapter has dedicated to braking down the components identified in the theoretical part, by analyzing what the current condition of the components such as understanding what is density and how we can measure it, what does walkability mean for this research, how do we incorporate public transportation, what does proximity to transit mean for our study and what type and kind of mixed uses we incorporate.

These analyses of the components helped the study to establish a clear focus on how to create the model for measuring urban parameters and what are these parameters for Transit Oriented Development. As indicated in Figure nr. 12 below these components are “challenged” as the classic components of TOD, however in the 2008 study by Jacobson and Forsyth, were they considered the best practices of TOD, the components were broadened to incorporate three new components related to the scale of implementation (reference of this can be traced back to the beginning of the concept of TOD, with Peter Calthorpe and the division of TOD into two basic typologies the neighborhood and the regional TOD) (Jacobson, 2008).
Emphasize human-scale design, which means that it should be based on comfortable walking distances between points. Specifically for TOD, this includes development within a quarter mile of a minute walk radius (doubled for key stops), with adequate density of residences near transit; provide transit-friendly regional

architecture (Seigman, 2003); (Dittmar H. P., 2004) There is a critical dimension; rather than the finer-grained challenge of designing buildings and spaces to be human-scale, the emphasis is on situations where uses coexist. Jacobson and Forsyth bring the attention back to the importance of TOD and its relation of the context stating the importance of the scale on with TOD is applied. Security is something new for this concept and has a crucial role for cities today. Security is linked closely to safety, which is a critical component of establishing welcoming public spaces and can be addressed in a variety of ways. These include physical measures such as enough lighting to prevent gloomy patches and promoting "a mix of residential uses to ensure 24-hour activity" (Dunphy, 2004, p. 176) The emphasis is on urban shape rather than architectural detail. Attractive public areas are diversified, vibrant, and entertaining, avoiding monotony in their appearance or use. In the design process, designers should consider the social, visual, and land use components of complexity (Dittmar H. P., 2004).

The pedestrian and cyclist orientation are something partially present into the walkability component, however it draws attention to the TOD rules place a premium on pedestrian-friendly roadway networks. Transit development must accommodate non-motorized modes of transport. Above all, open spaces should be adaptable, accommodating a diverse range of users and activities at varying times (Jacobson, 2008).

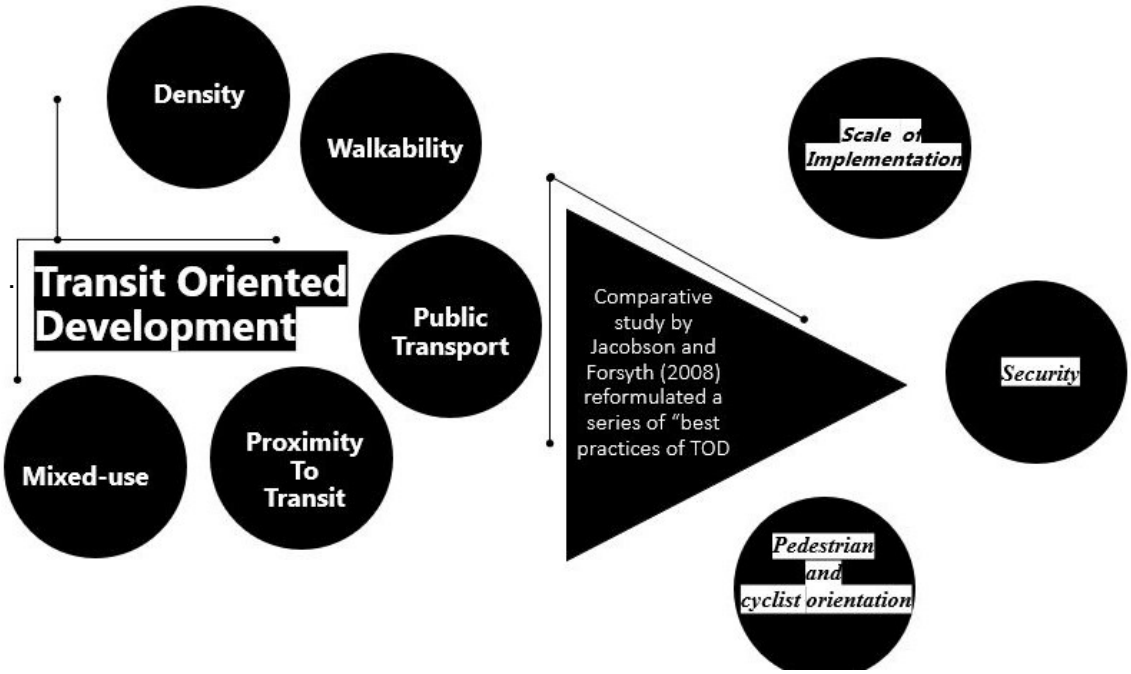


Figure 12. The components of TOD, a comparative study of the classic components found in TOD definitions and project / Authors elaboration

4.10 The components and principles of TOD-Density, diversity and design

The majority of past TOD research has focused on suburban and greenfield areas where transportation and urban growth coexist. TOD has received little attention in large cities with well-developed transit networks. In these cities, transit stations are usually placed in dense areas, such as Central Business Districts (CBDs), and rail traffic is substantial. Even in these massive metropolises, however, the traditional urban pattern of a single urban center is rapidly being superseded by a more polycentric form.

4.11 TOD as a Narrative concept

There are many different planning theorists who have argued that planning theory should "dig deeper into learning processes where the tacit dimension of knowledge is involved" and that planning should move away from "grand stories" and toward narratives of the "underprivileged," as well as toward an "epistemology of multiplicity" in planning (Ameel, 2020).

Plot structure can be generated using a planning domain in an emerging use of automated planning known as "Interactive Narrative". To ensure system replicability, narrative planning domains must be able to generate a wide variety of narratives, and they must also be able to adapt robustly to failures in story execution due to user engagement. Looking at how narratives are regarded as persisting or even deceiving their listeners through Marxist approaches to the study of narrative (Ameel, 2020).

Roland Barthes states that narratives are part of everyday, we use them and find them everywhere (1977: 79). Narrativity, or what makes a story tell itself, has long been an object of debate within narrative theory.
The majority of theorists define narrative as "the portrayal of an event or group of events," like Porter Abbott's (2008: 13) definition of narrative. As a result of this lack of agreement, narrative theory, says Abbott, has been largely abandoned as a method of investigation. However, although many of these theories consider narrativity as an inherent quality of a text, others lay greater emphasis on what we as readers do to activate texts as narratives (Thomas B. , 2016).

The paradigm shift from a top-down type of planning to a more dialogic, participatory, and discursive form of planning (Fischer, 2009) entails a shift toward the recognition and increased use of diverse urban narratives. In the wake of the argumentative turn, new analytic techniques to designing narratives emerged, drawing from rhetoric's (Throgmorton, 1993, 1996) and the analysis of story lines and discourse coalitions (Throgmorton, 1993, 1996).(Hajer, 1993) If planning methods have become more discursive and dialogic, this necessitates a conception of the planner as a moderator of possibly opposing narratives (Mandelbaum, 1991).

Considering the planners role on the narrative concepts and their presence in literature as dominant ideologies, some paralyzing with the Calthorpe's TOD can be drawn, on how the concepts its view and translated. Since TOD does not have a clear definition, rather than translated into a context base narrative (Banister D. , 2018).Tod is treated as model of development, rather than a narrative concept, however the TOD-ness or application of TOD is mainly treated as a bottom-up narrative for planning.

4.12 How does Narrative model become a theory?

Narrative theory begins with the premise that narrative is a fundamental human technique for making sense of fundamental elements of our experience, such as

time, process, and change, and proceeds to examine the particular nature of narrative and its different structures, elements, uses, and effects (Cebik, 1986). By drawing on concepts from fields such as rhetoric, (sociolinguistic), philosophical ethics and cognitive science, including cognitive and social psychology (folklore and gender theory), narrative theorists can investigate how narratives function as both types of texts and strategies for navigating experience (Cebik, 1986). Planning theory is the collection of scientific concepts, definitions, behavioral correlations, and hypotheses that characterize urban planning expertise. In this respect, urban planning theory may be described as 'a broadly, systematically logical explanation of the growth of cities and the urban planning process; an intellectual framework utilized to comprehend urban development and planning process' (Cao, 2013). Using the taxonomy of urban planning theory, we deduce that there are three stages of urban planning theory: philosophical, scientific, and technological (Cao, 2013). If we think of theory as an all-encompassing framework of explanation, we are doomed to disappointment.

4.13 How do we integrate Paradigms into Theory?

A planning doctrine is defined by Faludi and Van der Valk (1994) as a set of interrelated and durable notions about the spatial arrangements within an area , the appropriate development strategy and guidelines about the ways both are to be handled (1994, p.18). Planning doctrine has two interrelated dimensions, that is, a principle of spatial organization and planning principles .

This normative theory must have a stable foothold of adherents in the planning community to become effective in coordinating decision-making within this community by ensuring consistency in planning decisions (Korthals Altes, 1995).

The paradigm shifts from a top-down kind of planning towards a more dialogic, participatory and discursive form of planning (Fischer, 2009) also includes a move towards the acknowledgement and increasing use of diverse urban narratives .

In the wake of the argumentative turn, new analytical approaches towards planning narratives appeared, drawing on rhetoric's (Throgmorton, 1993; 1996), and the analysis of story lines and discourse coalitions (Hajer, 1993).

If planning practices have moved towards becoming more discursive and more dialogic, this entails a vision of the planner as a moderator of potentially competing narratives (Mandelbaum, 1991).

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Urban planning is increasingly conceived as a form of "persuasive storytelling" (Throgmorton, 1996), with planners actively engaging in "city story-writing" (Healey, 2000, pp. 527–528). Three distinct types of narrative exist in the context of urban planning: narratives for, in and of planning .

4.14 Theory Gaps

The "narrative turn" was sparked by the advent of structuralist narrative ideas in France in the mid- to late 1960s. However, the prevalence of narrative as a subject of study across multiple disciplines necessitates those scholars, teachers, and student have access to a comprehensive reference resource – one that cuts across disciplinary specializations to provide information about the core concepts, categories, distinctions, and technical nomenclatures that have developed around the study of narrative in all of its manifestations.

After almost three decades of supporting a nearly idealized TOD approach for enhancing local communities while promoting a modal shift contributing to the reduction of gas consumption, transit-induced gentrification has recently emerged as a matter of" concern .

The narrative concept within this study concentrates on the narrative of the planning theory of TOD, the concept itself in literature is defined as theory, however many analogies can be drawn from the depicturing of TOD in plans and reports, which brings it closer to a narrative notion.

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5 FIFTH CHAPTER – Methodology / Proposed research method

5.1 Roadmap to the Methodological approach

As a result of the overall collision between qualitative and quantitative research that occurred in the first part of this research, we have defined the beginning of this research path that is based on an analytical research of the data collected from the selection of our four case studies, shifting from a theoretical study, with the collection of data in the Tirana case, through primary research, and the analysis of the historical pathways that the theory takes, helping us set the theoretical framework In the second stage of this journey, we will look at deductive research, which will take into account data collecting from the case studies as well as spatial analysis based on the criteria that were derived from the case studies .

The format of the research is based on prior work that discusses the concept of TOD and its practical implementations. Using these concepts, a design dimension is constructed to enable comparisons of the selected case studies. These elements have been informed by global best practices in TOD as well as urban notions generated via past study. The analysis will determine the efficacy of TOD in a variety of metropolitan settings.

As a response to urban growth, this study examined four TOD projects in the US and Europe, taking into account the rationale for TOD's evolution from US experience, and using eight distinct types of urban design assessment tools to evaluate existing TOD guidelines and reformulate "best practices" for urban design.

Allington, Virginia, Portland Oregon, Copenhagen, Denmark, and Vienna, Austria, are all examples of "best case" TOD implementations that demonstrate the TOD components in different contexts, starting with Allington, Virginia, Portland Oregon, and European case studies such as Copenhagen, Denmark, where TOD was not the primary focus but had a significant impact on their planning continuity and development.

Our methodological approach to this research has followed a qualitative and quantitative approach, focusing on the theoretical study of the concepts, drawing historical pathways that enable the setting of the theoretical framework, establishing both the real scope of this research and the limitation of the theory. The deductive research part focused on four pillars of research, the first data collection though the reports and national database of each plan for our fourth different case studies, the literature review of this case studies present in many similar research papers that had drown different focus, the critical literature review of our main authors such as (Calthorpe, 1993), (Bertolini, 2007), (Corbett, 1996), (Cervero, Ferrell, & Murphy, Transit-Oriented Development and Joint Development in the United States:A Literature Review, 2002), (Dittmar H. G., 2003), and many more contributing to the reflection of their expectation and understanding of the case studies that have incorporated TOD. In our last four chapters (chapter 6, chapter 7, chapter 8 and chapter 9), we deal with the great focus on international best cases case studies which serve as pillars for this research in order to establish the application of TOD in, different context, periods and successful development, but also pave the way for the analyses of the Tirana context, opportunities and possibilities of data analyses that further the construction of the TOD tool model for future application.
This step by step process will not only allow the researcher to transmit its findings, contrast and compare with our “best cases” , but will also provide a adaptable tool that can be used in different context to measure the urban parameters of a TOD model, in both existing and proposed typologies.

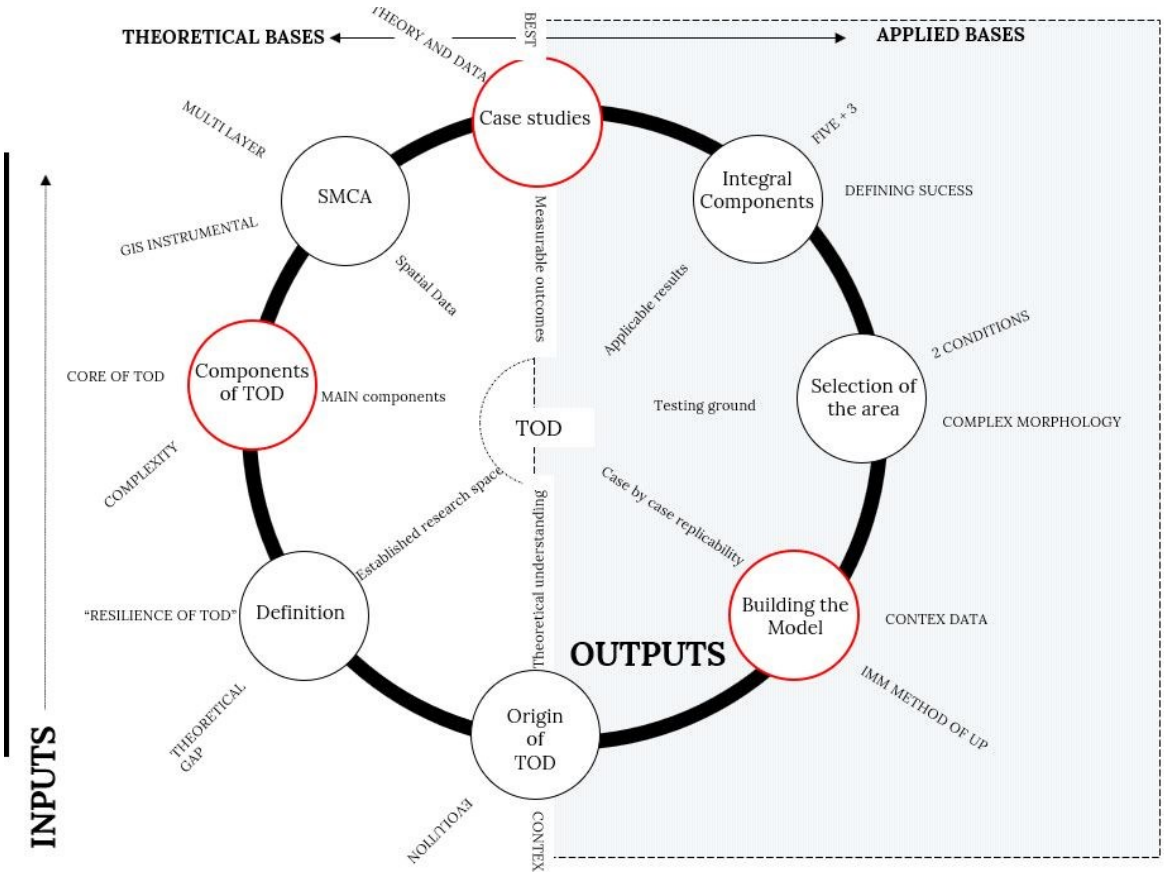

Table 4 The Roadmap of the overall methodological design for the research of TOD conducted by the researcher. Source: Authors own elaboration

5.2 GIS Instrumental Method

Aerial imagery has been one of the most broadly adopted data sources for geographic information systems (GIS) for more than 30 years. The field of earth observation has grown tremendously in recent years as sensor technology has improved and a rising number of operational satellites have been launched by various space agencies and businesses throughout the world.

Spatial/geographical coordinates are the basis of a geographic information system (GIS), a type of information system. Furthermore, GIS is a set of data manipulation operations as well as a database system with unique capabilities for geographically

linked data This map can also be considered an intelligent map that can be analyzed by a computer because of its higher level of detail and intelligence.

Geographic information systems (GIS) may be defined as an information system that can be used to store and retrieve geospatially referenced data, manipulate, analyze, and output this data in order to support land-use and environmental decision making, as well as transportation, urban facilities, and administrative records.

Photographs of geographic features (such as manufactured goods) will be used to retrieve GIS data for the purposes of this study. Traffic control, transportation flow analysis, vehicle navigation, and trip counseling are all dependent on GIS road data. Using GIS as a tool, this research will aid in the integration of spatial components.

GIS will be used for this research with satellite imagery in a timeline to before the application of TOD components, to collect partial data of the case studies and through the process of digitalization and after the application of the components , and paired" with the database for this case studies spatial data we will be able to put together a complete special feature include modeling, optimization, and simulation functions required to produce , assess, and evaluate the TOD components. Taking into consideration the TOD model of development, which is translated through its components utilizing GIS (model builder) to consider each of them individually .

Each city has its own personality and style, as do the kind of people who live there. Criteria and performance metrics were selected based on the study region in order to determine the level of TOD. Making sure what performance measures are available and set up standard information correctly after finalization. Both geographical and non-spatial metrics have been included in our study.

Additionally, using the SMCA approach, generate the TOD index for aggregating all performance measurements into an index form.

5.3 SMCA Methodology

In order to resolve our hypothesis, we will use the spatial multi criteria analyses, divided into steps and tools. The Spatial Multi Criteria Analyses[9] comes as a way to evaluate different forms of inputs and output by using instruments such as Geographical information systems (GIS).

Compose a collection of rigorous procedures for the evaluation difficult judgments and facts with this strategy. For the purposes of this research, the methodology is broken down into smaller components, including data collection and the creation of a database based on land use using Geographical Information Systems (GIS), followed by the identification and derivation of criteria and indicators for each criterion that will be used in this research.

One of the most critical applications of GIS is the visualization and analysis of data to aid in decision-making. A decision can be defined as a choice between various behaviors, locations, or items. For instance, one may be tasked with determining the optimal location for a hazardous waste facility or with determining which areas are best suitable for new development.

This research will take an analytical approach to the indicators generated from the provided criteria within the context of a GIS, which will be explored in detail later. These indicators will be compared to the transit-oriented development model's specific needs for urban form, and the findings will be explained using maps, quantitative and descriptive indicators, and other tools.

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9 See Spatial Multicriteria Analyses Toolbox ***: http://eprints.lse.ac.uk/12761/1/Multi-criteria_Analysis.pdf***

Mixed use, pedestrian-friendly environment, high-quality public transportation system, increasing density and affordable housing all contribute to TOD's ability to enable clustering of activity. Having all these things in one place has the potential to change people's travel habits, which necessitates additional investigation. Using a range of criteria, a decision-support tool and statistical technique known as "multicriteria analysis" can evaluate numerous possibilities or scenarios in a decision (Rashed, 2003).

For transit-oriented development, spatial multicriteria analysis can be described as an approach that incorporates and transforms spatially-referenced data (input) into a vulnerability score (output) as shown in table nr. 5 below the combination of data and criteria is the derivate of the multidimensional technique.
Two strategies are particularly valuable because they allow us to address the application of transit-oriented development components through a series of steps in which the components are considered as spatial decision data under uncertainty. The proposed technique begins with the selection of a set of criteria for comparing the outcomes of the TOD components in a real-world setting (Rashed, 2003).
This method will focus on three main steps, starting with the selection of the criteria that will later be the bases for the analyses, then stepping into the GIS will prepare the cartographic materials and data attributes for these criteria to be measured, and finally we will define the index of data aggregation for our case studies.

Step I- The selection of the criteria of analyses

Pre–TOD assessment begins with the selection of a development and confirmation of its TOD components. "Without evidence, the measures used in pre–TOD evaluation, such as mixed-use developments or projects located near transit stations, may be believed to have some TOD-like transportation features. Despite certain similarities, these technologies operate in distinct ways.
In our case studies the Criteria will match the components of TOD, starting with the measure of Density, for each of our areas, proximity to transit and alternative mobility, the level and distribution of mixed uses in our area and finally will focus on the walkability and permeability within the area.

Step II-Map Preparation, data attributes translation

For the integration of diverse activity centers through increasing accessibility, the TOD's land use composition is critical. Because of the wide range of land uses, a wide range of journeys are generated and attracted. In a TOD, trip attracting land uses outnumber trip generating land uses by a large margin. Thus, TODs tend to draw more trips than all modes of transportation do, resulting in higher trip attraction rates than trip output rates. It is essential to have a variety of modes of transportation accessible to ensure that these journeys are carried out in a sustainable manner. The preparation of the cartographic materials will facilitate the process by connecting with each case study (state national geodatabase system) in order to process and use context appropriate data that are updated and useful to this study. In our case we have accessed four national database systems that have aided this process.

Step III-TOD index aggregation

Professionals in transportation believe public transportation, walking, and cycling more sustainable than automobiles. Three factors were used to evaluate TOD study creation: land use mix, parking, and sustainable transportation infrastructure. If the chosen development does not match acceptable TOD standards, a different type of development should be investigated. While SMCA is a methodologically diverse approach that gives numerous possibilities for adopting the generic framework stated above, Vincke's (1986) 'taxonomy' of SMCA techniques provides a useful means to reduce the choices. The aggregation of our data will be based on the combination of the data index from each case study national database and planning document in place, which was reviewed for the purpose of this study in each of the four case studies scaling the necessary data. The aggregation will be based on the index established by the Allington, Virginia case in the recognition of the spatial patterns that have changed into and since the beginning of TOD implementation, the reference for this case can be found in the “Transit villages of the 21st century,

case of Portland (Bernick, 1997) and Transit oriented development, Make it happen (Curtis, 2009).

This technique separated the spatial impact of changes in land use patterns and transit service. The findings were presented as a dimensionless density index (later defined by case), walkability, transit, and permeability, and were compared across four distinct TOD initiatives in both the United States and Europe. Coverage that is proportional to the population, frequency factor, trip time, and employment that are within walking distance. The proportion of accessibility change attributed to transportation was quantified using a variable. Accessibility was discovered to vary according to a variety of factors. The schematic representation of the Malczewski created in 1999's, relates to the roadmap of the application of the spatial multicriteria analyses in our case (see Table 5).

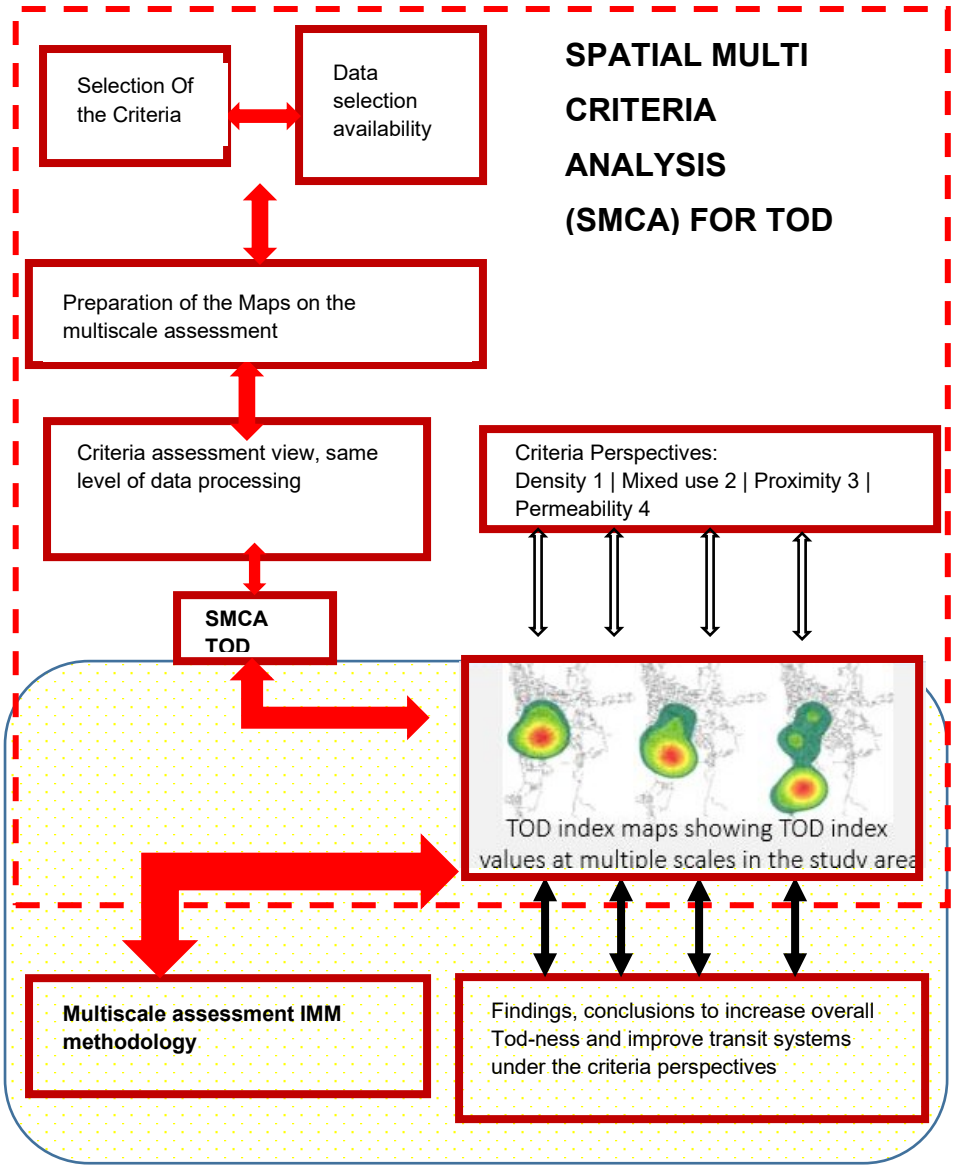

Table 5 The SMCA Design for the evaluation of TOD in our case studies/ Based in Malczewski 1999 model. Source: Author's elaboration on the method using our criteria and steps

5.4 Indicators of TOD

As the complexity of urban systems is formed by the synergistic integration of vital components, meaningful combination of various components is possible to get insight into the urban condition. A paradigm shift in how urban indices such as density, FAR, and so on are evaluated will be achieved by using this method. Subsystems are characterized by physical traits and configurations and used to analyze the relationship between urban morphology and energy consumption, as well as environmental performance. As a result of this design strategy, the goal is to create a more environmentally friendly and efficient city (Mitchell M. , 2009).

As with any other system, a building's components and subsystems are complex. A thorough understanding of the spatial and temporal extents of cities, as well as their expansion tendencies, is essential in order to effectively monitor and map urban growth as well as build efficient urban planning strategies. Some instances of urban expansion include the redevelopment of existing built-up areas at a higher density, the infilling of residual open space, and the creation of greenbelt land around urban centers.

As an example, we have used Spatial Multicriteria Analysis in our case studies to extract data from Arlington, Virginia's open data platform (https://gisdata-arlgi.opendata.arcgis.com/datasets/ArlGIS::arlingtoncountyboundarypolygon/explore?filters=eyJDT1VOVFkiOlsaN)and other locations. As part of our example, the planning unit breaks up the essential data into the four polygons (polygon 158, polygons 168, polygon 142, polygon 112) in order to retrieve it (the smallest division unit within the area). Finally, the collected and filtered data was overlay and (clipped) divided by infrastructure axes (common division mode applied in many countries). This information has been compiled into one database (virtual space within GIS for data management) and analyzed based on FAR, Density, Proximity to Transit, Proximity to CBD, and Permeability (walkable space) calculations in each part region. A

normalization value specified in Arlington; Virginia's technical report was used for the final data transmission.

Each of our case studies, such as Portland, Oregon(https://gis-pdx.opendata.arcgis.com/search?tags=development),Vienna,Austria (https://www.eea.europa.eu/data-and-maps/data/eea-reference-grids-2/gis-files/austria-shapefile), and Copenhagen, Denmark (https://freegisdata.org/place/), followed this predetermined procedure Table nr. 6, how the four Matrix of Comparison sent for each of our scenarios, which serves as a foundation for our best-case scenario comparison and contrast with our Tirana local case study.

criteria

Working Activities 400 meter	Travel accessibility 500 meter	Travel behavior 500 meter	Density INDEX	Proximity to CBD	FAR
1 (low less than 15% (5 highest more than 50%)	1 (350-500 meter access) 5 (100-350 meter access)	1 (frequency of travel every 5 min) 5 (frequency of travel every 10 min)	0-0.05 Low 0.05-0.07 medium 0.07-0.09 High	1 (350-500 meter access) 5 (100-350 meter access)	According to the plan

Normalization value

Table 6 The criteria of evaluation of the case studies with the normalization value defined by the Arlington, Virginia case Source: Authors own elaboration based on the Arlington, Virginia development strategy.

6 CHAPTER SIX – CASE STUDIES

6.1 TOD in US Cities / Europe, Case studies

Case studies entail a methodical and in-depth examination of a single example, which is frequently constrained by its geographical location. There is already an abundance of TODs in North America, and examining them all would take considerably longer than the time allotted for this research endeavor. As a result, an inquiry was conducted on a small number of TODs that were previously regarded "successful." However, this concept's introduction into Europe is not novel or surprising.

The current body of knowledge measures TOD performance according to the number of design components present in the neighborhood, such as high density and a mix of uses. As previously stated, a TOD may contain the majority or all of these components but fail to capitalize on its proximity to public transportation.

6.2 An enquiry of the motivation after TOD

This study analyzed four TOD projects in two distinct contexts: the US TOD (taking into account the rationale for the concept's evolution from US experience) and the European TOD as a response to urban growth, utilizing eight distinct types of urban design assessment tools to evaluate existing TOD guidelines and reformulate a series of "best practices" for urban design.

The case studies that serve use as “best case” are chosen to demonstrate the components of TOD into different context, starting from Allington, Virginia, Portland Oregon that represent cities developed though TOD interventions and European case studies were TOD was not the main focus, such as Copenhagen, Denmark but influenced greatly into their planning continuity and development, the case of Vienna as an European experience was based on the components of TOD, with a focus on walkability, services and long-term sustainability. The differences between our case studies:

Geographical location: Two of our case located in the US cities (Arlington and Portland), studies represent the “classic” TOD implementation, thought its components. The European case studies of Vienna and Copenhagen represent an entirely different context in planning approach and development. An important component to consider is that the US case studies since before the implementation of the components had a great reliance on car-oriented transport, in the case of European cities due to historical development and origin of the urban planning have a considerable shift in public transport.

Period: The case studies are always a work in process due to the dynamic urban development, however the US case studies provide historic data since they started the implementation of the TOD as early as the 1970’s, the European Case of Copenhagen started in the 1947’s, however the plan is always in development and adaptation and was recognized as TOD intervention in the late 80’s with the expansion of the western corridors. The case of Vienna provides a newly incorporation since the plan started its conception in 2010 and was officially published in 2015.

Land Use: The case of Arlington and Portland are mainly commercial uses; the case of European TOD are more residential uses.

In addition to this component the case studies have been viewed into different perspectives and components as well, such as the mixed-use level in the areas, walkability index measured by the 10 mile walk or 500-meter radius as translated

into our study, the proximity to central services, the density and the open space ratio. In general, this concentrated research on urban components related to TOD identifies a variety of themes and topics that are both significant in and of itself and also offer concerns for future research.

6.3 Arlington, Virginia TOD

6.3.1 The overall expectations from the development of TOD

Arlington's prominence as a county has increased since the 1970s, owing in part to its proximity to Washington, DC.

Realizing a specific aim, such as increasing the demand for higher-density structures in areas near public transit and urban centers, is essential. Develop a pool of developers with previous experience building higher-density mixed-use projects in suburban settings. By incorporating high-quality architecture into urban-style structures, you may increase public acceptance of them. Participate in the creation of new places and the building of a sense of belonging in your community.

Arlington's primary goal was economic development and growth control in order to protect low-density communities, but the initiative also had positive environmental effects from decreased private vehicle use.

For all journeys, public transit usage is doubled, cycling is tripled, and walking is six times higher than in the rest of the area. In comparison to adjacent suburban areas, total vehicle miles driven per capita in the transit corridor is slightly lower. (D. A, 2000)

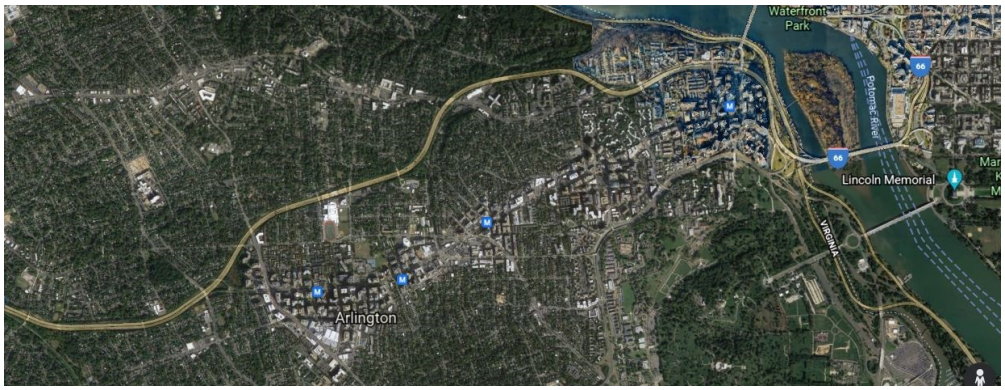

Figure 14 Arial view of the Arlington Rosslyn-Ballston corridor Source: Google Maps, January 2021

Arlington's successful transition to transit-oriented development was not without its challenges, especially in terms of improving the station areas' pedestrian design. Even though the TOD principles upon application improved the overall area, the increase of public transport within the area was more related to design of walkable spaces and the number of people living within the range of the walkable distance near the stations.

Improved pedestrian design, such as uninterrupted and direct sidewalk access and a healthy atmosphere to drive through, may help to reduce private vehicle usage even further. Private sector investment in transit-oriented growth in Arlington was promoted by the county's long-term planning, which was matched with public infrastructure and urban design investment incentives.

High-density development was encouraged within a 0.4-kilometer walking radius of Metro stations, and mixed-use development, which combined industrial, retail, and residential uses in the same building or location, was encouraged.

6.4 Translating TOD

High-density construction was encouraged within a 0.4-kilometer walking radius of Metro stations, and mixed-use development that combined industrial, retail, and residential uses in the same building or area was encouraged . (Cervero R. , Land Use Mixing and Suburban Mobility, 1988)

Infrastructure, public amenities, and urban design upgrades were funded by the county and the private sector, demonstrating the value of public-private partnerships.

Arlington exemplifies how transit-oriented development can be built and coexist with traditional automobile-oriented development .

The system will be a hybrid underground/commuter railway, dubbed Metro today. Arlington will have ten stations, five of which would be located along a three-mile, failing commercial corridor that stretches from Rosslyn to Ballston (RB) in the county's northern part .

The decision did not guarantee TOD, however, as some residents banded together to push for the preservation of low-density communities along the corridor by planning park-and-rides at each stop .

The county listened to their concerns and developed a General Land Use Plan (GLUP) that would limit the highest densities to a walking distance from each station.

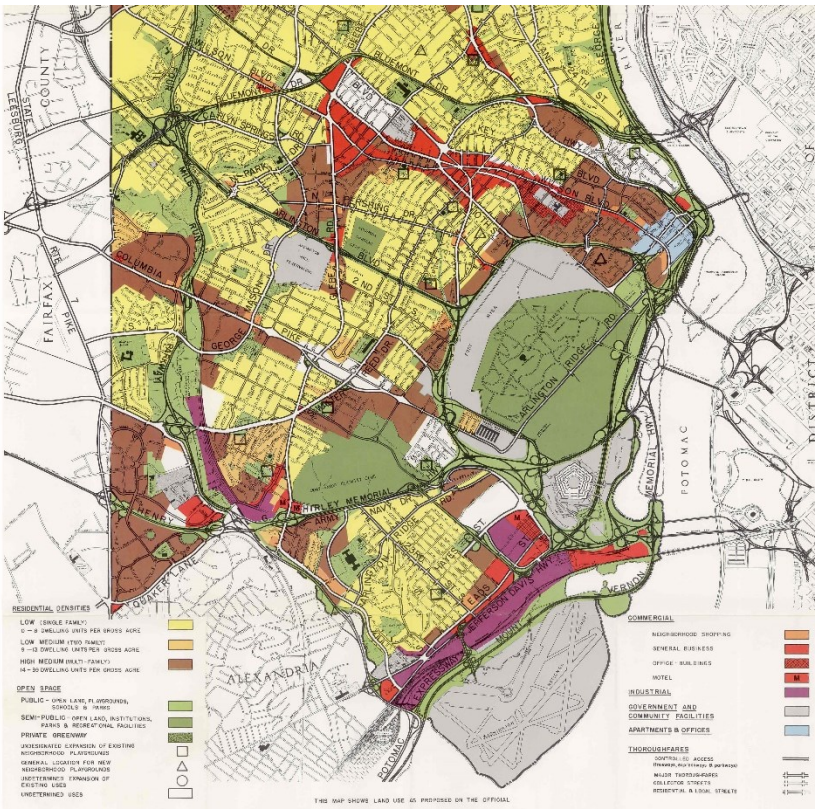

Figure 15 The Arlington's General Land Use Plan map Source: Arlington county General Land Use Plan document, June 30, 2018 /https://arlingtonva.s3.dualstack.us-east-1.amazonaws.com/wp-content/uploads/sites/31/2017/02/GLUP Booklet Dece

6.5 Why a successful TOD

The Rosslyn-Ballston corridor, which is home to some of the country's most popular TODs, is one of the busiest transit lines in the area.

The area has developed into a booming business district and a lively downtown where people want to live and work.

These TODs are thriving urban centers surrounded by a dense network of transit-friendly neighborhoods, and they serve as excellent examples of what TOD policy can accomplish. One of the main reasons why the Rosslyn-Ballston corridor is a model for TOD success is because of its high transit ridership. (Brinklow, 2010)

Ridership was also strong along the Rosslyn-Ballston route, which includes many station areas, and has almost double of percentage of ridership that the region according to US census bureau publication of 2008. Since 1980, office construction along the Rosslyn-Ballston corridor has exploded, transforming the area into a Class-A office market.

The retail business in Rosslyn-Ballston has also performed exceptionally well. Currently, the transit corridor contains half of all retail space in the county.
Market Common, a mixed-use center adjacent to Clarendon Station, was built in response to this trend to draw shoppers to the city. As a result, retail in the Rosslyn-Ballston corridor is doing exceptionally well, thanks to the large number of customers who live, work, or commute through the city.
In the transit corridor, housing has also performed exceptionally well. What was once a low-density industrial thoroughfare has become a mixed-use, high-density corridor.

Figure 17 Arlington County's Smart Growth Journey, Rosslyn – Ballston Corridor a compare sent between 1979 and Today, Source: 2017 American Planning Association National Planning Achievement Award for Implementation . http://www.pgplanning.org/DocumentCenter/View/9199/Article-on-Arlington-County-SGJRB-Corridor-9-18

Rosslyn, Ballston, and Clarendon are all communities with a deep sense of belonging. Clarendon Alliance, for example, is a neighborhood group that brings together residents and business owners to address issues in the community and promote the area to other areas.
The three TODs along the Rosslyn-Ballston corridor that were sampled are all high-density, mixed-use centers. All station construction must include dense, mixed-use developments in compliance with the General Land Use Plan to ensure that each station has its own sense of community.

6.6 Portland, Oregon

6.6.1 The overall expectations from the development of TOD

Many of Portland's planning strategies are seen as models in other cities. Re-zoning land adjacent to light rail stations to build new mixed-use development has been a key policy for the Portland area .

A New Urbanist initiative was followed in many Portland cases, resulting in well-connected, pedestrian-friendly streets and a diverse mix of housing, retail, and civic uses .

Portland's downtown station areas have a high level of intensity, the region's non-downtown station areas have a low level of intensity . Notably, there appears to be a strong distinction between the intensity of Portland's core station areas (in blue, which includes the Portland Streetcar) and the intensity of the region's non-core station areas (in green, clustered in the chart's lower left corner).

Portland Metro's Transit-Oriented Development Program was the first in the country to be granted permission to use federal transportation funds to purchase land for renovation next to a light rail station in 1998 . This program was used to develop Metro's 2040 Growth Concept, which emphasized transit villages and main streets. (County, 2008)

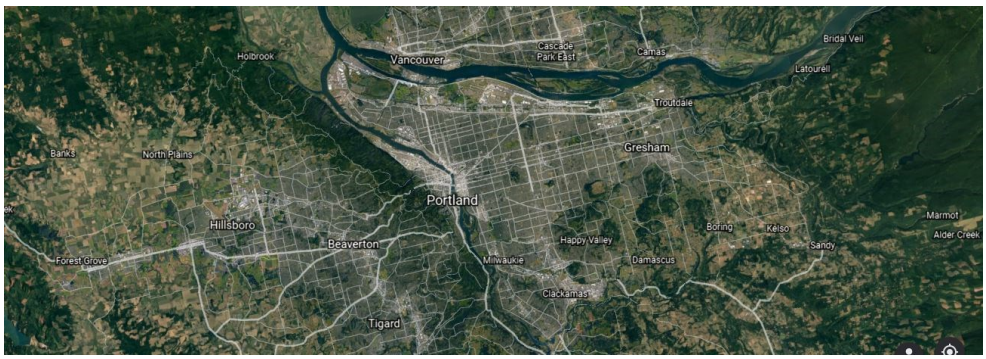

Figure 18 Arial view of the Portland, Oregon TOD topologies Source: Google Maps, January 2021

Orenco Station is a New Urbanist neighborhood in Hillsboro, Oregon, located just 15 miles west of downtown Portland . Orenco's growth started in the 1980s, when

the city made a deliberate planning decision to attract high-tech industrial development, such as Intel, NEC, Fujitsu, and Toshiba, to the area.

Pac Trust, an industrial and commercial developer, bought the Orenco Station lands and developed the entire area around the MAX light rail station. Orenco Station is one of the most widely cited TOD examples today, but there is much controversy about its popularity.

As a result, while transit ridership is comparable to that of other popular TODs, the surrounding area continues to be car-centric.

Hillsboro agreed to construct more than the minimum necessary parking spaces after Pac Trust, which owns land near the station, negotiated with them. Pac Trust also built parcels nearest to the highway system first, while owning land on both sides of the station.

Neighborhoods are built in a way that resembles small urban communities, with residents interacting and participating in community activities. Orenco Station's architecture follows this concept, with homes with narrow side yards rather than the traditional suburban big backyards.

It is hoped that by reducing the amount of private space and increasing the amount of public space, more leisure time would be spent in shared spaces, resulting in more interaction. Furthermore, pedestrian-friendly streets and sidewalks connect to the main town center, where residents can get to know their neighbors and socialize in a central location. Many of the design concepts developed by TOD pioneers were adopted by Orenco Station. (Carlton, 2014)

Figure 19 Portland TOD Corridor development Source: A CNU Journal by Robert Steuteville in May. 2, 2018. https://www.cnu.org/publicsquare/2018/05/02/connected-and-walkable-suburb

Higher densities were chosen in particular to establish a typical urban neighborhood that would benefit from its proximity to public transportation. Orenco seems to do

better in some areas than others. Many of the TOD design features are present: high densities, vertically mixed uses, and higher ridership than the rest of the country. Orenco Station, on the other hand, is still a car-dependent neighborhood, with massive surface parking lots and suburban-style shopping malls.

Given the fun walking experience, residents still prefer to drive their vehicles, despite the site's proximity to public transportation.

Typologies have recently become a popular method for structuring short- and long-term investments in transportation communities in many cities and regions across the country . A TOD typology is a way of classifying and distinguishing the region's many transit-rich neighborhoods by grouping them together based on key common characteristics .

6.7 TOD in European experience

6.8 Copenhagen, Denmark

6.8.1 The overall expectations from the development of TOD

Two factors characterize the capacity for growth and transformation: the attractiveness of the urban environment as a dynamic state, and the various drivers of urban change as processes.

The growth of distinct communities and identifiable cityscapes that are represented as urban characteristics.

Orestad is a linear new town in Copenhagen that will be developed over the course of 30 years around stations on an elevated, driverless mini-metro line. The construction of the Copenhagen Metro was to be funded by the selling of publicly-owned property along the route to developers . Since the internationally renowned 1947 Finger Plan, Copenhagen has had a 60-year track record of transit-oriented growth.

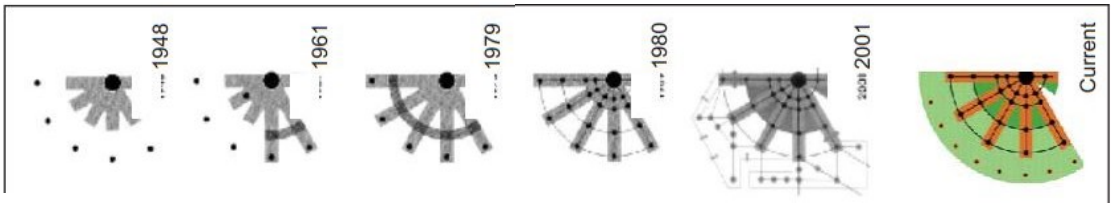

Figure 22 Copenhagen finger plan development, Greater Copenhagen plan 2005

The main principle of this plan: Access to green space, Urban development to follow transport, Proximity to natural spaces, Development linearly,
Densification and mix use, Transit nodes for transport, Overlap Multimodal transports., multi-center development, Center not for cars, Long-term development

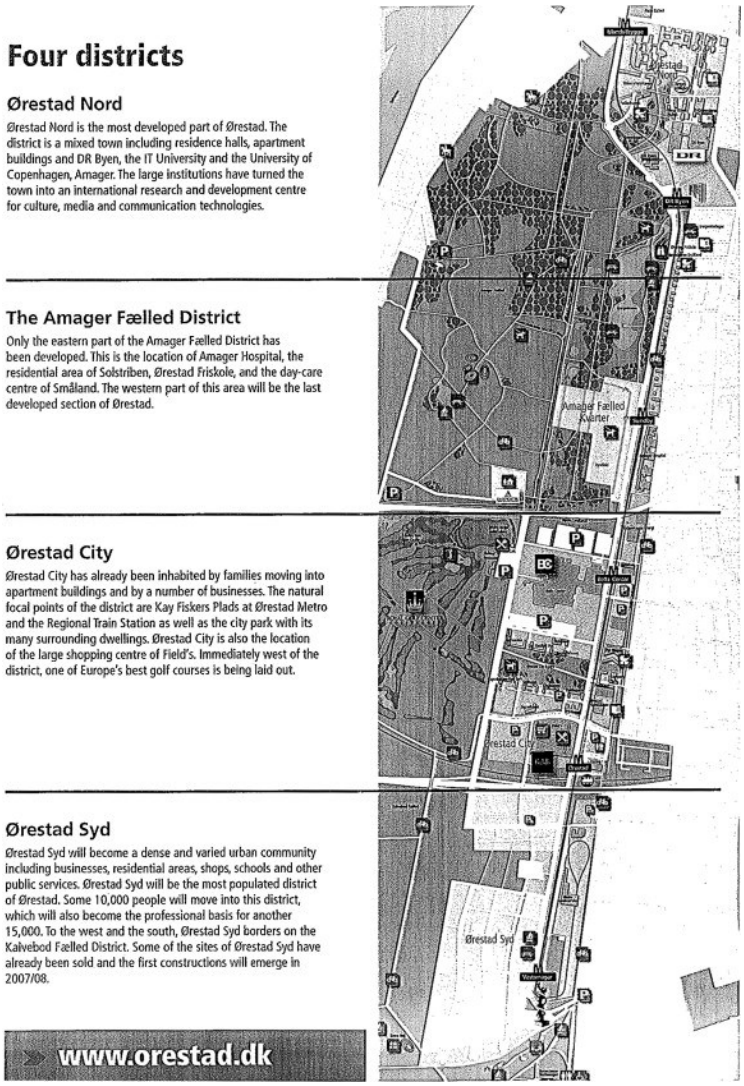

Figure: 28 Four main districts of TOD corridor development in the extension of Copenhagen Finger plan, Source: Copenhagen plan revision 2018 https://www.ovpm.org/wp-content/uploads/2018/09/copenhagudanemark.pdf

6.9 Vienna, Austria

6.9.1 Findings from the case studies we reviewed

TOD (transit-oriented development) is a strategy that promotes the use of public transportation by designing and developing dense, pleasant, and walkable urban environments. TOD is concerned with synchronizing urban life - its growth and development, daily activities, and mobility patterns - with public transportation networks in a wider sense.

Figure 29: Venna Step plan 2030, The develop ment corridor of the south, Vienna step plan 2012

6.10 Spatial analyses

The Spatial analyses will start with the scale of implementation, in a spatial comparison set between our four case studies, considering seven main criteria for each case in relation to the case implementation, giving us access to almost 30 parameters.

These parameters translated into spatial analyses maps, have been translated into a spatial dimension of 500-meter radius (in accordance of TOD components and Leon Krier distance of walkability), considered with the main notes implemented into the TOD projects, from design to implementation. TOD was conceived to be a flexible concept, each city, region or state can develop it according to need and context. There are no set rules and development does not have a standard process.

Figure 14 The 10 miles radius of the area considered for the index measurement within the node, map from Arlington Virginia scale 1:8000, Source Authors creation

The considered criteria started by classifying the scale into three main groups, starting from the first group the radius defined the measurement starting from the center of the node. The second group followed the same practice increasing the radius to 500 meters.

Taking into consideration services within the area into the two different type radius groups, considering travel accessibility the density index , proximity into the central districts area, FAR parameters, and LUC parameters . These indicators will eventually provide a well-rounded comparison with all case studies providing some similarities and unveiling essential components of applying the TOD indicators and how . Grengs (2004) demonstrated a method to measure changes in transit accessibility on one neighborhood from Buffalo and another from Rochester , New York by developing a gravity model using Geographic Information Systems (GIS).

This method separated the combined spatial effect of shifts in land use patterns and transit service . The results were obtained in the form of a dimensionless neighborhood accessibility index (NAI) and were compared at two points in time ,

1990 and 1997. NAI was based on proportional coverage, frequency factor, travel time and employment within walking distance of transit stop (Equation 2.13). A variable was used to represent the share of accessibility change attributable to transit .

The accessibility was found to vary due to different causes, in Buffalo case it improved because of changes in transit service while in Rochester study, accessibility improved because of changes in land use . The analysis was mainly for transit dependent poor people who live in inner–city neighborhoods. It may not be obvious why spatial data requires special treatment and why substantial research in transport planning still applies non-GIS based data analysis, despite acknowledging that it is addressing inherently spatial processes. Given the relatively recent diffusion of GIS technologies and analytical tools, research has relied on concepts of distance, adjacency, neighborhood, and network (Figure 8), without questioning the relationships between attributes and the spatial location.

As described by Harvey (2008 p. 629), it is the “mechanistic approach that ignored the spatial, temporal, and individual interdependencies among transportation, land use and population”, which “has left a legacy of urban areas with seriously inappropriate land use and transportation systems.”
Brown’s (2008) investigation of land-change dynamics, integrating survival analysis with GIS, presents urbanization as a unidirectional land-use transformation process, driven by a complex array of factors (Zhang, 2001). Once the land has been developed, the infrastructure is expected to last for decades (at least) and land-use changes may result in rigid, highly inflexible frameworks that are constraining opportunities for future modifications. The minute human actions have sculptured a new urbanized face of the earth, the resultant transformations, such as the core settlement and economic fabric and intertwined transport network, continue to dominate human life in perpetuity and represent nearly irreversible influences.

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The effects of Detroit's fall in the 1950's made it an example of a disarticulated planning process, with disruptive effects on the functioning of the city until the present day . Create new market comparable for higher density buildings near transit and urban centers. Cultivate developers with expertise in higher density mixed-use buildings in suburban settings . Increase acceptance of urban style buildings through high quality design . Carry out placemaking and contribute to local identity as a result of the TOD Program, six projects, ranging from small to large, have been completed .

Portland, Oregon[10]

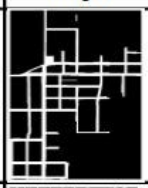
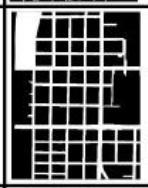
	Portland, Oregon	Working activities 400m	Travel accessibility	Travel behavior 600m	Density index	Proximity to CBD	Walkability index	FAR	LUC
section 5/3		3.1	1.1	3	536	2.4	1	1.35	30-40
section 5/4		4.2	2.2	2.6	655	2.5	2	1.6	35-45
section 5/8		3.3	2	2.9	356	3	2.5	1.2	40-50
section 5/6		1.5	1.5	2.5	256	3.1	3.2	1.1	55-65

Table 7 Portland Oregon Matrix of data overlay using SMCA Source: authors own elaboration

The first set of parameters started the same for all the considered case studies from the Portland Case study (Table nr. 7) to Vienna, considering our choice of

[10] *the 1755 Lisbon earthquake, more recently the 2010 and 2011 Canterbury earthquakes in New Zealand or earthquake related events, such as the Tsunami impacting the east coast of Japan in 2011; the emerging response to sea level rise triggered by climate change for many low-lying cities around the world*

methodology the corridor of development was divided into 1 mile matrix which divided the area into 1 mile * 1-mile squares.
The areas were the starting point for the multicriteria analyses, using GIS and particularly ArcMap we created a model that involved nine parameters that were initially, picked apart from our database of each case study based into the national database of each country.
These initial data have both measured into the geographical dimension on the database, compering these data with the data extracted from the national plan and the institute of statistics of each country, updated no less than 5 years from the extraction of the data.
After each parameter was compared and identified it was represented into our geographic space with a basic component of GIS, a shapefile.

The Database was then created as a merger of each data from each category and each case study into the matrix comparison, within the model measuring the derivate data of each parameter (such as FAR= Total surface of build environment* number of flours /Sub-traction area of subdivision within the general plan).

Each Section was compared within the area and between the two scales of implementation and translated into a scale of implementation. Starting from the lowest value (for example the concentration working activities within the 400 meter of proximity and the number of activities within the 1*1 mile of initial square, and later from the section of the 1 mile's radius to the 400-max limit of the walkability possible valued at 0,1,2,3 etc.) to the heights value not going over our comparison setting scale of 10 point indicating the max of value from the model, subtracting the total of the max value from the matrix and adding our valued scale.

The purpose of this matrix is to understand the value of each component and how each component finds its place within the overall project applicability by quantifying the data representing the physical development of each component in the geographic scale of a unit of 1 mile with 1 mile considering the walkability index and development of the corridor depth.

The tables set below represent the translation of the data into our case studies and our finding, from each component and the role they play in the overall development of the TOD corridor.

We must consider that even though the selected case studies are quite different in origin, implementation and development. This selection was quite intentional since the theory has such a wide application and the context of application is very diverse but also represents two different cultures of applications. The American based case studies have a different approach to the data and translation of the components, even though the basic components find their application into all our case studies.

Arlington, Virginia

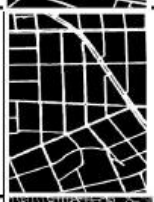
	Arlington, Virginia	Working activities 400m	Travel accessibility	Travel behavior 600m	Density index	Proximity to CBD	Walkability index	FAR	LUC
section 12/4		4.2	1.2	2.1	458	1.8	3	1.35	40-50
section 12/2		2.1	2.2	2.2	322	1.4	1.7	1.52	30-40
section 12/6		3.6	3	2.6	238	1.2	2	1.2	25-35
section 14		6.4	2.6	2.2	562	3.1	3	2.1	40-50

Table 8 Arlington, Virginia Matrix of data overlay using SMCA Source: authors own elaboration

Copenhagen, Denmark

	Copenhagen, Denmark	Working activities 400m	Travel accessibility	Travel behavior 600m	Density index	Proximity to CBD	Walkability index	FAR	LUC
section 14/5		1.6	0.7	2	785	2	1.1	1.4	40-50
section 14/7		3	1.4	2.1	652	2.3	1.4	1	35-45
section 14/6		3.2	1.9	1.5	801	2.5	3	1.4	30-40
section 14/10		3.5	1.4	2.2	463	1.7	1.5	0.7	30-40

Table 9 Copenhagen, Denmark Matrix of data overlay using SMCA Source: authors own elaboration

Vienna, Austria

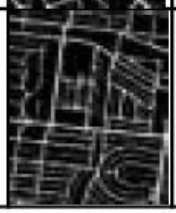
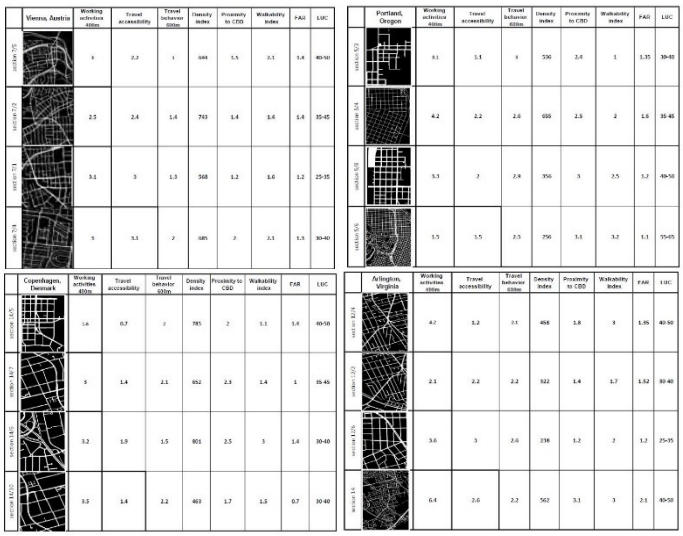
	Vienna, Austria	Working activities 400m	Travel accessibility	Travel behavior 600m	Density index	Proximity to CBD	Walkability index	FAR	LUC
section 7/5		3	2.2	1	644	1.5	2.1	1.4	40-50
section 7/2		2.5	2.4	1.4	743	1.4	1.4	1.4	35-45
section 7/1		3.1	3	1.3	568	1.2	1.6	1.2	25-35
section 7/4		3	3.1	2	685	2	2.1	1.3	30-40

Table 10 Vienna, Austria Matrix of data overlay using SMCA Source: authors own elaboration

The matrices above depict the universe of activities in which the TOD Program currently invests, and in which it could invest more significantly in the future if additional funding is available . Each of the matrices is used to distinguish between activities that are core to the program, activities that are more incidental to the program, and activities where the program personnel only provide assistance to other agencies .

The use of the Spatial multicriteria analyses in our case studies is based on the data platform from each of our selected areas particularly we have accessed their national open data database to extract the country data in the case of Arlington, Virginia(https://gisdata-arlgis.opendata.arcgis.com/datasets/ArlGIS::arlington-countyboundarypolygon/explore?filters=eyJDT1VOVFkiOlsiNTEiXX0%3D&location=38.877561%2C-76.962900%2C11.00), this data has been selected in structured

query language (SQL) to retrieve only data that corresponds to our four sections within the administrative boundaries of Arlington. In retrieving the necessary data in our case (polygon 158, polygon 168, polygon 142, polygon 112) these areas are divided by the planning unit (the smallest division unit within the area). The collected and filtered data have than been overlayed and (clipped) separated by main axes of infrastructure (common division mode applied in many countries). Finally, this data have been incorporated into a single Database (virtual space within GIS to manage data), and have been measured according to the calculations of FAR, Density, Proximity to transit, Proximity to CBD and Permeability (walkable space) within each section area. Finally, the end data have been transplanted using the normalization value found in the Arlington, Virginia technical report of the plan. This process followed this designed step for each of our case studies, Portland, Oregon (https://gis-pdx.opendata.arcgis.com/search?tags=development), Vienna, Austria (https://www.eea.europa.eu/data-and-maps/data/eea-reference-grids-2/gis-files/austria-shapefile)(https://www.wien.gv.at/stadtplan/en/)Copenhagen, Denmark (https://freegisdata.org/place/51139/) in order to provide valuable input for our case study compare sent as best case scenario. The conclusion of these data was extracted into four Matrix of compare sent for each of our cases (see Figure 11), providing the bases for our best-case scenario to compare and contrast with our local case study of Tirana later on.



Vienna, Austria	Working activities 400m	Travel accessibility	Travel behavior 600m	Density index	Proximity to CBD	Walkability index	FAR	LUC
section 1/C	3	2.2	1	644	1.5	2.1	1.4	40-50
section 2/D	2.5	2.4	1.4	743	1.4	1.6	1.4	35-45
section 3/A	3.1	3	1.3	568	1.2	1.6	1.2	25-35
section 4/B	3	3.1	2	685	2	2.1	1.5	30-40

Portland, Oregon	Working activities 400m	Travel accessibility	Travel behavior 600m	Density index	Proximity to CBD	Walkability index	FAR	LUC
section 1/D	3.1	1.1	3	536	2.6	1	1.35	30-40
section 2/A	4.2	2.2	2.6	686	2.5	2	1.6	35-45
section 3/B	3.3	2	2.8	356	3	2.5	1.2	40-50
section 4/C	1.5	1.5	2.5	256	3.1	3.2	1.1	55-65

Copenhagen, Denmark	Working activities 400m	Travel accessibility	Travel behavior 600m	Density index	Proximity to CBD	Walkability index	FAR	LUC
section 1/D	1.6	0.7	2	785	2	1.1	1.4	40-50
section 2/C	3	1.4	2.1	852	2.3	1.4	1	35-45
section 3/B	3.2	1.9	1.5	801	2.5	3	1.4	30-40
section 4/A	3.5	1.4	2.2	403	1.7	1.5	0.7	30-40

Arlington, Virginia	Working activities 400m	Travel accessibility	Travel behavior 600m	Density index	Proximity to CBD	Walkability index	FAR	LUC
section 1/A	4.2	1.2	2.1	468	1.8	3	1.85	40-50
section 2/D	2.1	2.2	2.2	922	1.4	1.7	1.52	30-40
section 3/B	3.6	3	2.6	238	1.2	2	1.2	25-35
section 4/C	0.4	2.6	2.2	562	3.1	3	2.1	45-50

Figure 11 The Data Matrix for the compare sent of our case studies

Source: Authors own elaboration

Main Findings

Working activities| services need to be very close (20%-30%) within the 400–500-meter distance

Travel accessibility should be between 3-5 high

Travel behavior need to be between from 100-500 so any indicator between the 1-5 is acceptable

Density index should be high between 0.05-0.07 to accommodate the services allocation
Proximity to CBD is not primary but it can be
between 350-500 m or even higher.
FAR is established by the plan, by default the
FAR needs to be high in the high-density areas.

In addition to our findings from the Spatial Multi criteria analyses, as part of the literature analyses, we have also created a matrix of the definitions of the Transit oriented development within each plan of our case studies in order to establish how TOD components have been incorporated into the plan. The matrix divides the information into main components present in the plan rhetorical description and the regulatory document that reflect the development criteria, the second components are components that are present, however not in all our case studies equally and there for have been categorized as secondary importance components, the third components are components that are present however they do not play a decision making role they are represented as goals or undirect objectives within the plans. The fourth and final components are complementary components that support the application of our first and second components though steps and guideline, or as spaces such as (strategic documents) for these components to take place.

Definition	***Important components***	***Secondary components***	***Third components***	***Supporting/Policies/ Instruments***
Arlington /Virginia	High and mid density	Preserve and reinvest in neighborhood	Expending Travel options	Strategic Planning Instruments
	Around Transit	Enhance open space		Future Traffic trends
	Mixed uses	Pedestrian and Bicycle environment	catalyze private development	
Portland/Oregon	mixed-use buildings	corridors according to market readiness	Guide future investments	Strategic Plan
	existing conditions			Strategically Target Program

Copenhagen, Denmark	mixes residential and commercial	maximizing access to public transport	optimizing the use of land	Regional Planning
	hubs		secure long-term	new development corporation to manage and act as planning authority for future regeneration
Vienna/Austria	mixed-use development	building a completely new district	value capture	
			growth in public transport	Strategic Plan
	Car-restrictive measures	maximizing access to public transport	Increasing quality of life	

Table 11 The Matrix created to evaluate the components of TOD as conclusion from our case study analyses of each of the case studies of Allington, Portland, Vienna, Copenhagen. Source: Authors own elaboration

While the TOD framework provides a general guide to the types of investments that are suitable in each station area and corridor segment, those types of investments must be tailored to the unique circumstances of each station area and corridor segment. Some aspects of TOD implementation , such as affordable housing construction, land acquisition, mixed-use and sustainable living facilities, and job uses, may need to be weighed against local market conditions and genuinely supportive local stakeholders , as evidenced by direct donations, abatements, SDC credits or discounts, and tax increment financing .

7 SEVENTH CHAPTER- COMPERATIVE ANALYSES TIRANA

7.1 Setting the stage | Tirana

Due to historical, political, cultural, and social factors, Albania's planning process has undergone many changes and challenges. All of these problems reshaped the planning methods and tools that are currently in use.
Despite the fact that these improvements improved the planning platform, many of the instruments remain static and inflexible, rendering the planning process even more complex and, in some cases, ineffective.
During the socialist period, the planning process was highly centralized. There was no definition of private property. All belonged to the state, so everything had to be carefully planned to achieve a particular goal. The design process was part of a larger effort to standardize architecture, lifestyle, and planning tools. The regulatory plan, which was very strict, was the main instrument in the planning phase. Its main function was to regulate and define centralized political initiatives. Having said that, we can see a strong distinction between two separate planning methods during this time span (the timeline refers to the pre-90's and after the 90's as two key timelines).

The first was the massive construction of new cities from the ground up with a predetermined number of inhabitants with no differences between them and regardless of their surroundings, something very common for the cities build during the socials time in Albania (pre 90's).

Albania was an example of a stable economy and growth at the start of the 1990s. Economic shifts, as well as cultural and urban transformations, resulted from the radical changes in the political regime. The two most important development requirements at the time were: The sprawl of main cities and the large concentration of settlements this phenomena started after the 1997 and lasted till almost the end of 2007.

Transportation challenges, solutions, and innovation stand as the main focus in the development agenda of cities today. As cities change, grow and become more complex, so do their needs and transport planning approach. The Transport Sector in Albania before the 90s was developed in line with the needs of the economy, focusing more on industrialized areas and areas with intensive agriculture and less on urban centers as a result of their expansion. Transportation was a state monopoly. After changing the system of government public transport as well as many other sectors and changed. The quality of its service decreases, creating a state of limitation in the lives of citizens. The transport sector after the 90s was developed dynamically. Despite the changes nowadays, our country is far from the standard of European Union countries. Main cities like Tirana are almost in chaos and people must spend hours to travel short distances, despite efforts to introduce alternative means of circulation.

Shift began in 1993, when the parliament passed the 7693 nr. Law “For Urbanism,” which aimed to establish, many reforms in the planning process, though many amendments were made to the same law from 1994 to 1997 (R.Toto, 2010).

The slow awakening of the state's lack of control and the lack of a proper planning system created a void in the country's management and planning, which was clearly reflected in the lack of measures and regulations to address the phenomenon of informal growth. The planning process was in disarray, and the planning tradition remained stagnant, with few planning instruments. The turning point in the creation of a new structure occurred in 2006, when, in response to external pressures and community-based organizations, the initiation of a document for territorial policies

began, with help from The United States Agency for International Developmen, USAID (The decentralization process).

7.2 Tirana | Transport Condition and Study

Tirana is the current capital of Albania and the largest city in the country . Mobility preparation is a critical component of this study's structure. As a result, we will divide Tirana's mobility planning progress into three phases, each reflecting critical changes in the country's overall development as well as historical changes that influenced social, economic, and territorial changes. The mobility planning process did not include any new infrastructure, instead focusing solely on the reconstruction of existing roads. From 2000 to 2005, it was time to reconstruct by investing in new and improved infrastructure.

This new approach resulted in the advancement of national infrastructure (improving Albania's connectivity with its neighbors) as well as an increase in city mobility planning. The reorganization of public transit networks in 2006, which was accomplished by public-private partnerships, increased the efficiency of city mobility planning.

The majority of Tirana's infrastructure is of the radial kind. The infrastructure is in good shape and consists primarily of primary roads, but since the city's rapid growth, a significant number of informal settlements have expanded the infrastructure into tertian roads.

7.3 Urban Development and Land use

The countries transition from a centralized economy to a market-based one has influenced many spheres including transportation, were it experienced a shift from the single centralized institutions that planed based on economic and uniform territorial connections “Central place theory” (Christaller, 1966) to long-term objectives and territorial cohesion planning. The new Tirana urban legislation will serve as a good starting point for a new set of town planning rules, which the country urgently requires. Regardless of the variations that may occur, the drafting of this new regulatory plan as a mechanism and in collaboration with many

specialist agencies and other concerned groups and communities is likely to be successful and not liable to raise concerns. The future of Tirana is a challenge that depends on the contribution of its people, the position of communities, private sector, and the leadership of the public administration, based on lessons learned from previous urban planning, current urban phenomena, and new proposed urban plans for Tirana Region (as outlined in this Guide). Another powerful motivator is Tirana's and Albania's drastic changes in the 1990s, especially in terms of urban growth.

7.4 How and why TOD in Tirana

“Walkable, compact, mixed-use, higher-density development within walking distance of a transit facility” is what transit-oriented development (TOD) is known as . TOD is a mixed-use development that aims to make public transportation more efficient, improve the convenience and safety of walking and bicycling , and create a vibrant, livable community. By the year 2025, 14.6 million households will demand homes within walking distance to public transit and rail systems. TOD can help meet some of that demand .

TOD has the potential to enhance public health. Vehicle dependency and congestion can be reduced in a city with a good and reliable transit system and streetscaping elements . It is thought that a TOD culture would boost community health and even reduce obesity. According to a study titled The Effect of Light Rail Transit on Body Mass Index and Physical Activity , commuters who used a recently built train were more active . TOD has the potential to make a society more resilient . Transportation accounts for about 28% of all greenhouse gas (GHG) emissions, according to the Center for Transit-Oriented Development's Planning for TOD at the Regional Scale . TOD, on the other hand, has the ability to minimize annual GHG emissions .

TOD has the potential to boost local economies. Improving local public transportation will reduce car transportation costs and travel time . People will be able to spend their time and money at local restaurants, stores, and museums as travel times and costs decrease .

A neighborhood with TOD components is less expensive than sprawling suburbia. Since sprawl construction necessitates the expansion of public infrastructure and services, it is expensive .

Community opposition and an unsupportive regulatory system are the two biggest obstacles to TOD . Although nearby property owners may be concerned that TOD would detract from a neighborhood's character or cause traffic congestion, TOD has been shown to be pedestrian and bicycle friendly, help local businesses, increase property values, and reduce sprawl .

For the purpose of this study, we recognize three important timeline stops in the transit/mobility development of the city of Tirana, these three important steps also serve us as a motivation as why we have established Tirana as a case study.
The first one refers to the 1920' regulatory plan of the "Zog" period, in which the city started the development of the main boulevard named after the Zog king, that gave a new face to the city and also kick started the development of housing along the main access, the second focus is the Tirana-Durres corridor in the beginning of the 2000's that linked Tirana and Durres in a strong unified axe which gave a new development orientation of the City and quickly this became the main economic corridor for the region. The third and final motivation comes from the 2015-2020 Regulatory plan of Tirana which reconsiders the idea of the outer ring of Tirana as the second ring-road that connects the city, this concept has present since the 80's and had a comeback as necessary mean of development according to the local government. The graphic illustration of these three important steps are illustrated in Figure nr.12 bellow.

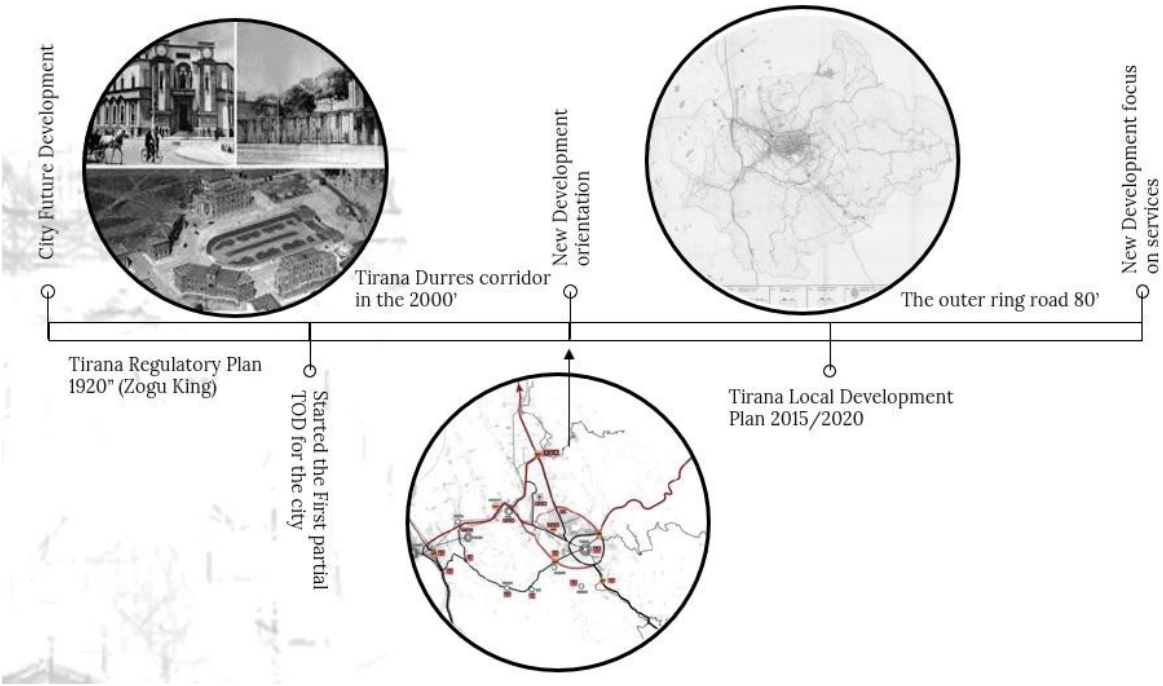


Figure 12 Tirana three development stops, the motivation behind the local case study focus Source: Authors own elaboration

7.5 Urban Policies and legislation

Local governments should review their regulatory structure to help TOD . The need for TOD and the roadmap for policy implementation should be included in comprehensive and master plans. Furthermore, zoning and land use ordinances must promote and endorse transit-friendly development patterns and regeneration strategies.

Automobile-oriented, single-purpose, suburban-scale construction should not be the primary focus of zoning ordinances and land development codes. To accommodate the construction density needed for TOD, zoning codes will need to be changed physically.

The planning process for TOD can differ from community to community. When a community has adopted a transit-friendly regulatory structure, a TOD study will begin (including comprehensive plan and codes) . A TOD analysis is used to

identify the need for improvements to a community's transit-served area(s) and to evaluate the potential for TOD around a proposed transit station/hub .

A public participation strategy should be developed to ensure feedback from all stakeholders. To oversee the planning process and engage community members, a town's planning board, a special TOD study committee, or an advisory may be created. A group may wish to hire consultancy services to help with the planning process.

The transition from urban sprawl to inclusive TOD is a critical issue that must be addressed immediately. It is, however, easier to conceptualize than to implement. Several interconnected and diverse elements must be aligned and brought together. Infrastructure, street, and building planning and design are among them, as are codes, regulatory reform, and finance .

Rail owners can cover capital costs of construction and secure long-term profits to offset operational costs once in operation by introducing smart transit hubs, or transit-oriented projects . They will meet critical development targets and smart city projects at the same time. In this way, transit hubs have the ability to serve as a powerful mechanism for implementing new growth strategies .

7.6 Transportation Background on Tirana

Tirana was named the capital in January 1920 by the Lushnja Congress. Along with the political factors of the time, it appears that the geographical location of Tirana possessed all the characteristics of an ideal settlement and capital, including the proper distance from the sea and the mountain, a very favorable climate, an abundance of natural elements such as water and greenery, fertile areas for agricultural development and population growth, and most importantly, was located in the intersection of important commercial routes. Time has demonstrated that this election justified the consecutive problems that Tirana would confront as a rapidly rising metropolis.

Beginning of 1917 and 1918, Austrian academics made the first attempts to map Tirana and its road network. On this basis, an Austrian engineer and architect drew up the first plan for the city in 1923, with the intention of correcting and regulating

the city's road structure to a more rectangular shape that would fit as closely as possible with the existing grid and also maintained the city's radial directions. In locations where building was not taking place at the time, the objective was to develop a quadratic network of clean drinking water. The enlargement of Durres Street, Kavaja Street, and Barricades was a result of this concept.

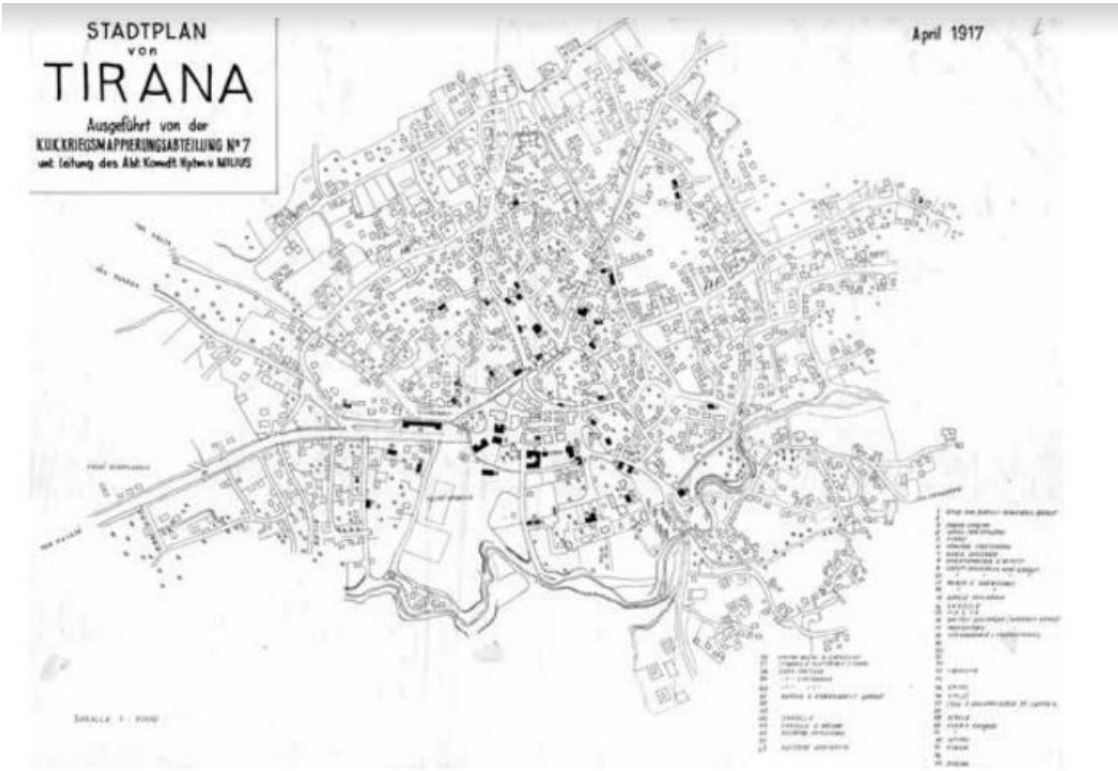


Figure 13 Tirana Plan map 1917 / source: National cartographic archive

It was in this context that architect Armando Brasini (a well known Italian architect …)was called to Albania in 1925, where he worked with the original proposal for the city's core. His concept was to create a central axis and a series of colossal structures that would not only introduce a new European trace into Tirana's oriental construction but would also serve as indicators of a new way of life. Based on the design proposed by Brasini, the city's northern section and the historic bazaar were feared to be demolished by the proposed axis.

However, while the Roman models of Cardo and Decumanus appear to have inspired the design of this axis, its adaptation to Tirana's specific situation is not

solely based in this abstraction, but rather on the clear orientation about local elements such as Dajti Mountain, river flows (originally Lana and the river of Tirana), hills raised at the beginning and end, etc.

For the first time at the city level, the Brasini proposal for the north-south axis that runs through Tirana was manifested in a more complete design produced in 1926. This plan was more of an adaption of the earlier in the year 1923 plan.
Changes and alterations were made in 1929 to the original 1928 plan. As part of this plan, the boulevard was extended further to the north, taking its full length of 2 kilometers from the royal palace to "Skanderbej" square and to the new stadium (where the train station was located up until a few years ago) located north of the boulevard (where it had previously been located).

Following this design, the city's borders (4.5 km2) and the most central sections along the boulevard, as well as the important historical entrance routes (Durrs Roads, Kavaja, and Elbasan) were delineated, as well as the places to be renovated and constructed along them. Layout presented a plan that included two main perpendicular axes: the vast north-south road as a "Cardo," which included the promenade Viktor Emanuele " (now Zog I Par Street) and the promenade of the "Empire" ("Dshmort e Kombit" boulevard), which featured a square on one side. Bus travel or philo buses were planned for in the plan's urban transportation section, which used the word "circumvallation" to describe the radial lines linking and circling within and beyond the circle of rings. Additionally, the plan called for the development of public transportation systems that would connect and operate across a variety of modes of transportation and public areas.

7.7 Breaking down the method

Integrated Modification Technique (IMM) is a novel design methodology based on a specific procedure with the main purpose of increasing the energy performance of CAS (Complex Adaptive Systems) by modifying its ingredients and optimizing the urban parameters. The Integrated Modification Methodology (IMM), created by

the Polytechnic of Millan department of the ABC (Tadi, 2015), is a multi-stage, multi-layer, multi-scale, holistic, and iterative procedure for urban components.

It focuses on the 'subsystems' characterized by physical characteristics and layout to examine the links between urban morphology. It also emphasizes the importance of acting not only on the physical properties of units (architecture), but also on the operation of the urban system, taking into account functions, services, transportation, resource management, and anything else that has the potential to influence citizens' behavior from an ecological standpoint. It takes a holistic, multi-layer, multi-scale approach to problem solving. According to this concept, the city is a dynamic Complex Adaptive System (CAS) composed of the synergic integration of a number of primary pieces , which give a specific physical and temporary arrangement of the CAS through their arrangement and the architecture of their ligands (Tadi M., 2013).
According to this concept, the city is a dynamic Complex Adaptive System composed of the synergic integration of a number of primary pieces, which give a specific physical and temporary arrangement of the CAS through their arrangement and the architecture of their ligands.

Key categories are the emergent processes of interaction between primary pieces to generate a synergy in IMM. The synergy between elementary pieces produces key categories, a new organization that emerges not (merely) as an added result of the properties of the primary elements.

In our case the key elements tying this methodology to our topic are the 7 components of TOD identified in the theoretical chapters. These components (density, proximity to transit, mixed use, walkability, public transport, scale of implementation, security, pedestrian and cycle orientation) will become the accord for the IMM methodology to translate the application of these components in our case study of Tirana. The methodology will translate the components of TOD into the context, allowing us to compare the indicators, extracted from the four case studies (as successful TOD applications) and measure the difference of context with these indicators. The final result will allow the researcher to understand

through data, what level of TOD we should and can implement in a variety of contexts. As a final step attached to this methodology we will connect to GIS our instrumental method, the formula of indicators measure, for each of the 7 components in a single model. Enabling the use of this model in every context, to measure and identify gaps and measures in the application of TOD, in an existing build context.
The IMM focuses on the 'subsystems,' which are defined by physical characteristics and arrangements, to explore the links between urban morphology, development consumption, and environmental performance.

7.8 The selection of the Area

Our corridor is located in the city of Tirana, which is the capital of the country and one of the densest urban centers. The corridor on which this area is located has a significant meaning for this study, since it connects the Tirana-Durres corridor build after the 2000s, were the largest number of companies and economic development alongside it, also one of the main access of connection with the north and the south of the country. Our corridor considers both the beginning of the highway and the new outer ring road, which is now partially finished as the second ring of the city, developed since the 2015' (we are referring to the western part of the ring road starting from the Dritan hoxha main road and following the ring road to the Tirane-Elbasan highway).

This selected corridor represents three completely different scenarios since at the beginning of the corridor where our first area is located, we have more economic area which is now changing due to the "build pressure" and its slowly changing its land-use from economic / industrial to more residential / service development in the last 3-5 years, from a low density to a mid-density (In compare sent to our two other areas). Our second area located at the midpoint of our selected corridor has started its development since the late 2017s where the area was not well connected with infrastructure, but high-density development has already in place due to the proximity the area had with the future infrastructure. The third and final scenario case area is located in the end of our corridor, as a newly developed area which

started the development in 2018 just after the ring road construction, the area is now consolidating development as residential area with services and mixed uses.

For the purpose of this study three interconnected areas are selected. In continuity of the criteria identified of TOD in the previous Sixth chapter the selection of the study areas is guided by two main criteria. Firstly, the selected area must represent one or more than one typology of TOD and, secondly, in order to include the three Ds of TOD basis diversity in the selection of the areas is a key component. The figure 15 shows the overall extension of our selected corridor in arial view.

Figure 15 The selected Corridor of study area / Map generated and extracted by the researcher from ArcMap 10.7.1 source: authors elaboration

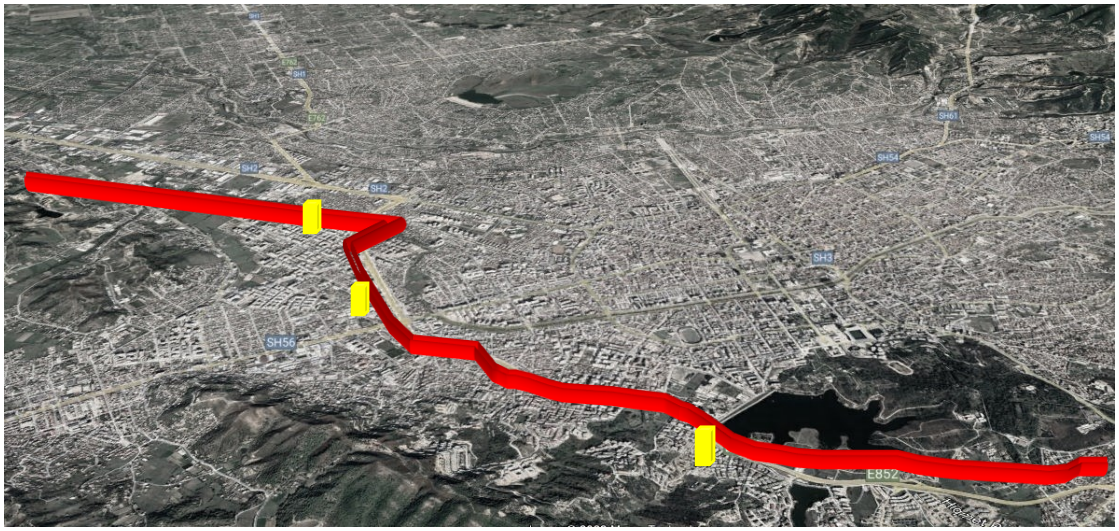


Figure 14 The overall corridor for the area selection of our case studies/ Isometric photo extracted from google earth pro Source: Author's elaboration

The selected areas start with an important corridor at the beginning of the Tirana-Durres corridor, continuing to the western part of the outer ring road, extending to the outer city Elbasan corridor. The selection of this continued area fits the two main criteria. The selected area, as an added value, differs in the typology of development, where the first part is the Tirana-Durres corridor is mainly an economic area, that slowly invited housing development, the western ring road is a newly high density build area that was just divided by the construction of the ring road, the final part of this section is the outside Tirana-Elbasan corridor a still developing area with low density private housing. The overall study corridor area is 20 km long, which makes it hard to apply the methodology throughout the entire corridor. In helping to frame the study subsections, to match our four initial case studies we will select 12 sub areas from the structural units of the local general development plan of Tirana 2030, which will reflect the typology, diversity and overall design of the section. The third and final area is a newly developing section near the Tirana artificial lake, this particular area is under development that has been supported by the ring road infrastructure.

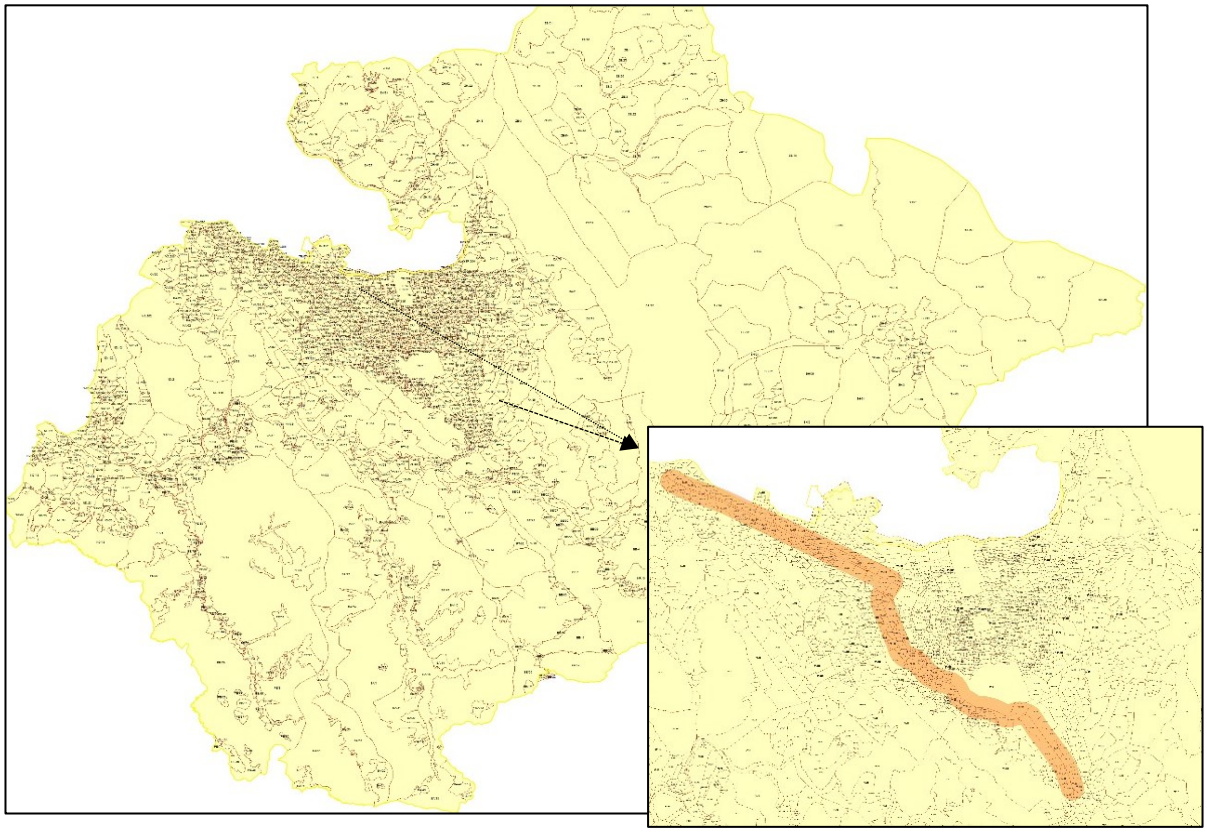


Figure 15 Map of the Structural units defined by the Local general plan, with a focus in the study corridor / Map extracted by the researcher from the ASIG national database

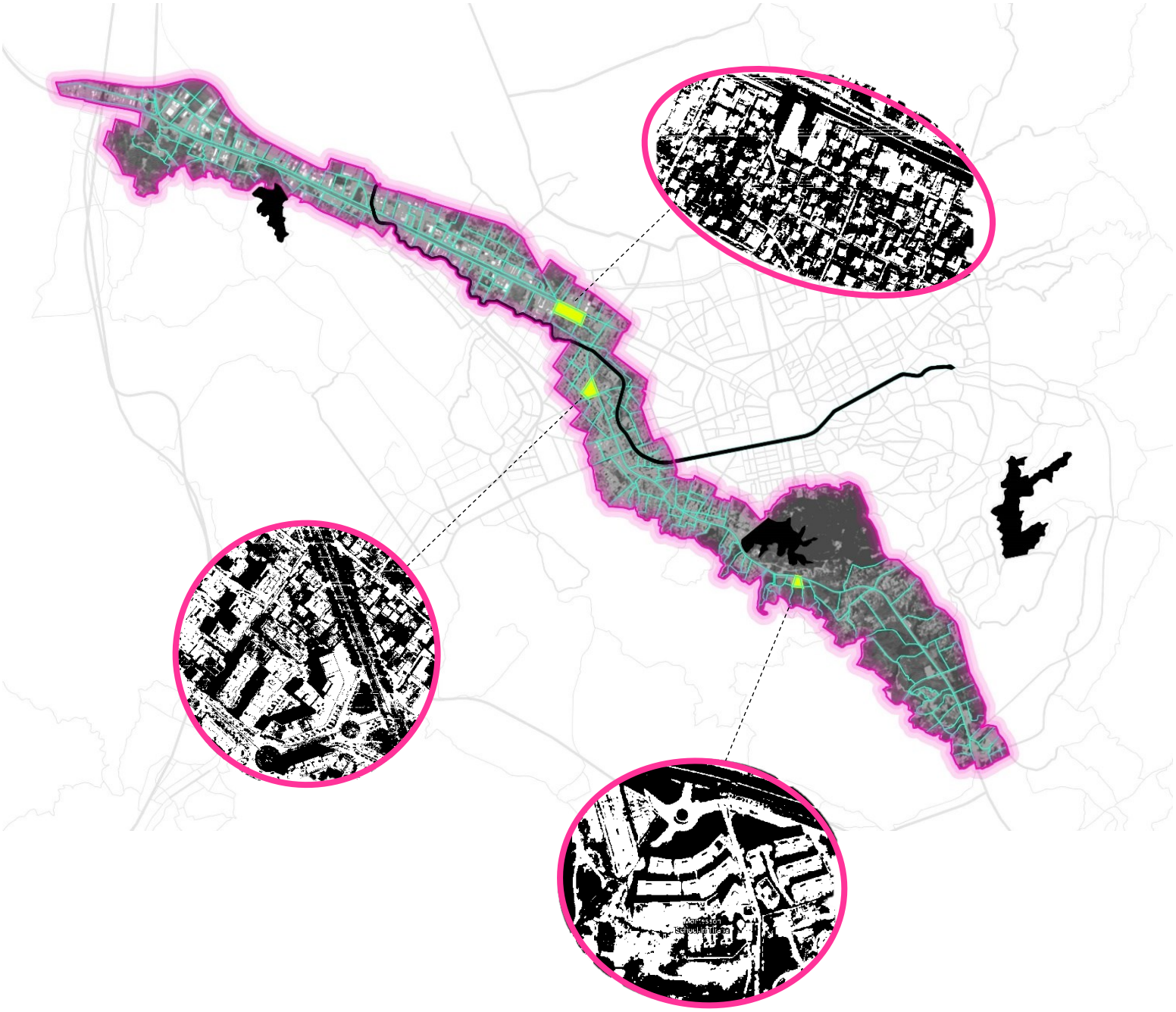


Figure 16 The area of study of the 240 units of division, Map created by the researcher 2021

Our first area is located at the edge of the Tirana- Durres Corridor, based on the division of the Tirana 2030 Plan division nr TR/441. The overall area does not Exide the 8 ha, and represent our first case study area Figure nr 17.

TR/ 441 Area 1

Figure 17 Arial photo of the area nr 1, photo of 2021 extracted by the researcher from ArcMap

118 buildings 2.45 km Infrastructure 16 services and business

The total surface of 78700- square meters with 17805 meters of existing build area, the existing 0.3 far and primary development of housing build, maximum of 7 stories build and 1322 of green area space and a population capacity of 5289 people.
The area was developed as an informal sprawl to the city of Tirana in the late 1998-2002. The first development of business started in 2005 with mainly commercial services. In the arial photos below we can track the development of the area (figure 16).

Figure 18 Arial Photo of the Area 1 extracted by Google Earth historic data 2003 by the researcher in 10.10.2021

Figure 19 Arial Photo of the Area 1 extracted by Google Earth historic data 2009 by the researcher in 10.10.2021

It is obvious by the observation of the two historical photos that the area started the development of large residential areas after 2010 with the infill of private houses and residential buildings, more that 8% of changes (in land use %) took place in the area, were land use changed from economic to residencia and mixed use (services and residential according to the Tirana Development plan of 2015 classification). These provide some evidence to land use changes that started in the area and

have sparked our interest in selecting this area(see figure nr 20).According to the Local development plan the area has a division between the economic / industrial part and the area is located somewhere in-between, however, the development of the residential land-use has crossed over to the part defined into plan as economic and industrial.

Figure 20 The proposed land-use for the Area nr 1 as a reference of the Local development plan 2015 Source: The national Government agency official website, Plan document https://planifikimi.gov.al/index.php?eID=dumpFile&t=f&f=2096&token=a9770f32412717de3162e553df0f70785f2472df

KA / 53 Area 2

Figure 21 Arial photo of the area nr 2, photo of 2021 extracted by the researcher from ArcMap

27 buildings 1.40 km Infrastructure 28 services and business

The second area is located at the edge of the Western Ring-road, based on the division of the Tirana 2030 Plan division nr KA/53 with a total surface area 36100-square meter, with 11332 meter of existing build area, the existing 2.41 FAR and primary development of housing build, maximum of 8 stories build and 7650 of green area space and a population capacity of 3060 people as measured by the local development plan in 2017. The area was developed as an informal sprawl to the city of Tirana in the late 1998-2002. The first development of large residential areas started in 2010. With the first development of infrastructure this was the start of business development and commercial services as illustrated in Figure 18 below.

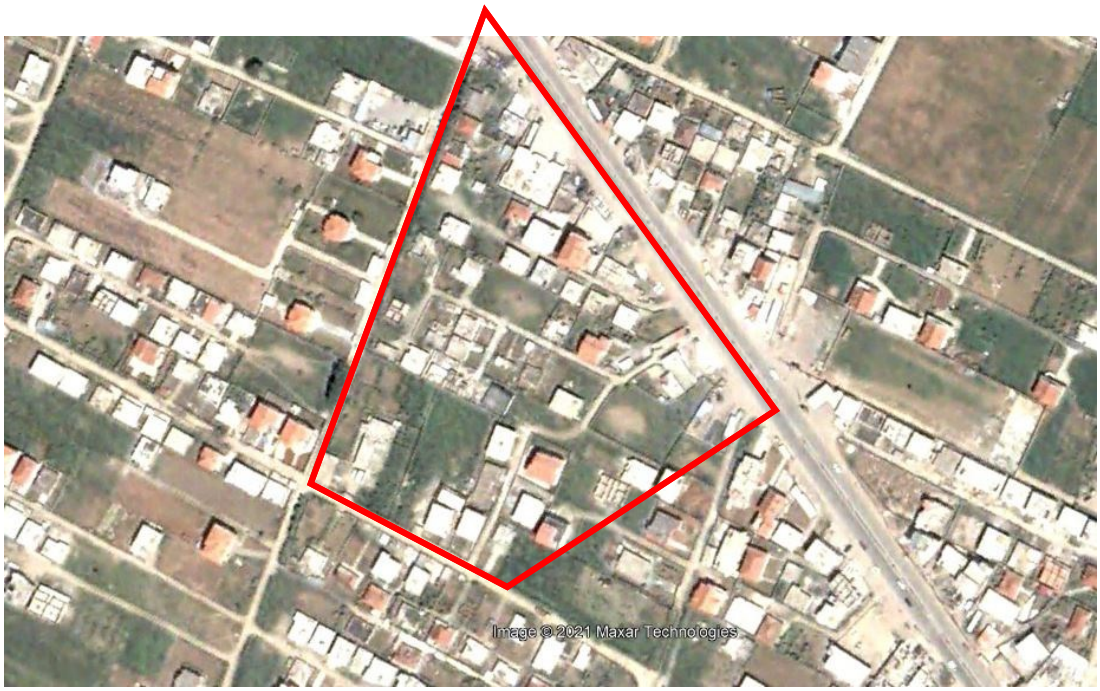


Figure 22 Arial Photo of the Area 2 extracted by Google Earth historic data 2003 by the researcher in 10.10.2021

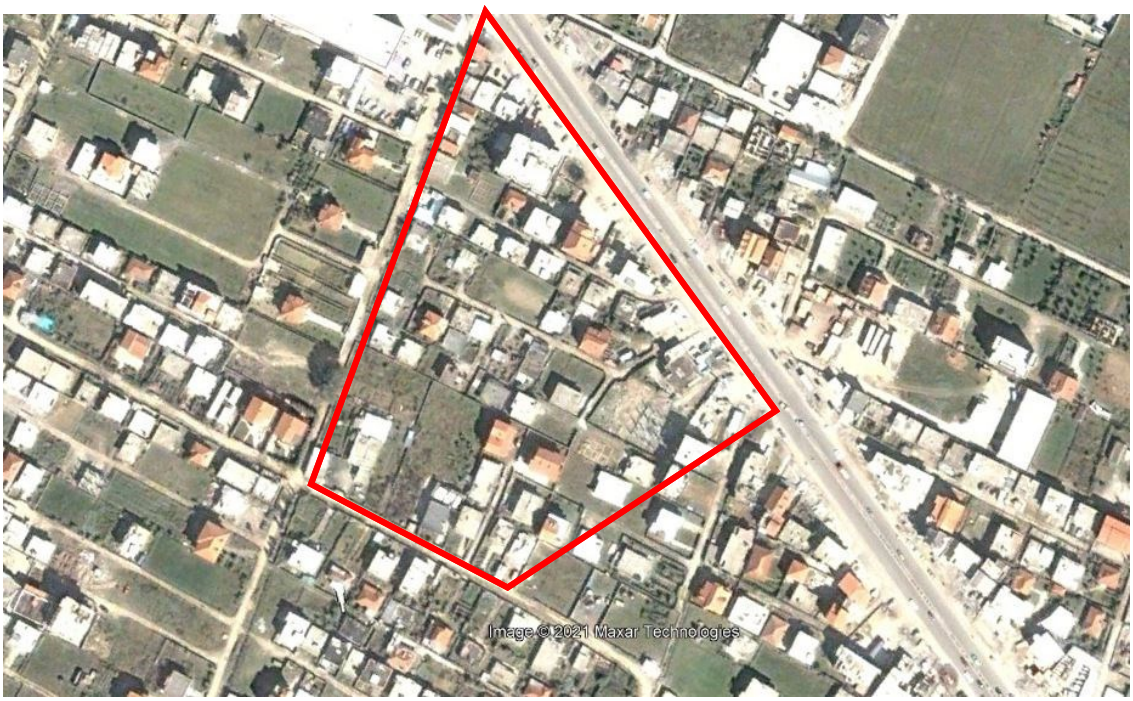


Figure 23 Arial Photo of the Area 2 extracted by Google Earth historic data 2009 by the researcher in 10.10.2021

Figure 24 Arial Photo of the Area 2 extracted by Google Earth historic data 2013 by the researcher in 10.10.2021

Observing the differences of the arial photos we provide a better understanding of the area. The main infrastructure axe was present since the end of 2002, however the redevelopment of the area started after the 2010 when the plan for building the outer city ring road was discussed, this development preceded this decision, since the infrastructure in place since 2002 also served as the main economic axe for mainly service industries. However, this changed dramatically after the building of the ring road due to the split this strong infrastructure implemented in the area. The area started morphing into a more residential mixed-use development and its continuedly growing to this day with new development on the inside of the area, since new infrastructure accesses have started to grow. This is something very normal for the area, since it has been identified as one of the areas with potential development, to supply the housing needs for the city. This can be illustrated in Figure nr. 25 , were the yellow color illustrates the areas that will be developed for residential and mixed use according to the local development plan.

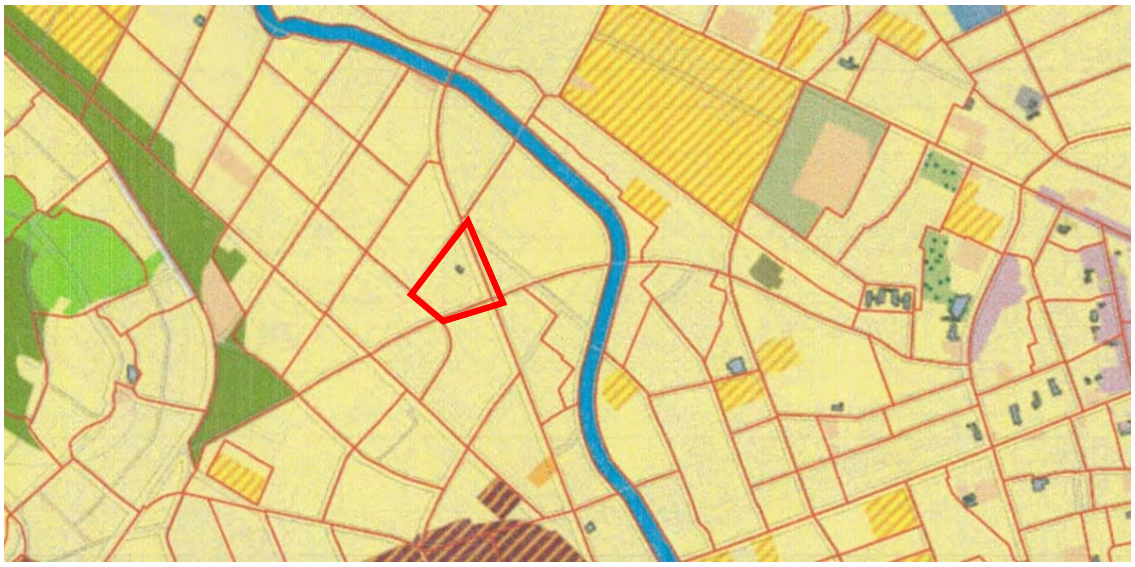


Figure 25 The proposed land-use for the Area nr 2 as a reference of the Local development plan 2015 Source: The national Government agency official website, Plan document https://planifikimi.gov.al/index.php?eID=dumpFile&t=f&f=2096&token=a9770f32412717de3162e553d

FA / 145 Area 3

Figure 26 Arial photo of the area nr 3, photo of 2021 extracted by the researcher from ArcMap

15 buildings 1.24 km Infrastructure 6 services and business

The third area is located at the edge of the Western Ring-road, based on the division of the Tirana 2030 Plan division nr FA/ 145 with a total surface area 14600 - square meter with 10434 meter of existing build area, the existing 0.72FAR and primary development of housing build, maximum of 3 stories build and 745 of green area space and a population capacity of 298 people (when?). The area was developed after the approval of the local development plan and has been developed in agreement with the indicators of development established by the plan. The development of the area started in 2020 as a new development area with low residence buildings, before 2020 the area was only a natural space as shown in the Figure 27 below.

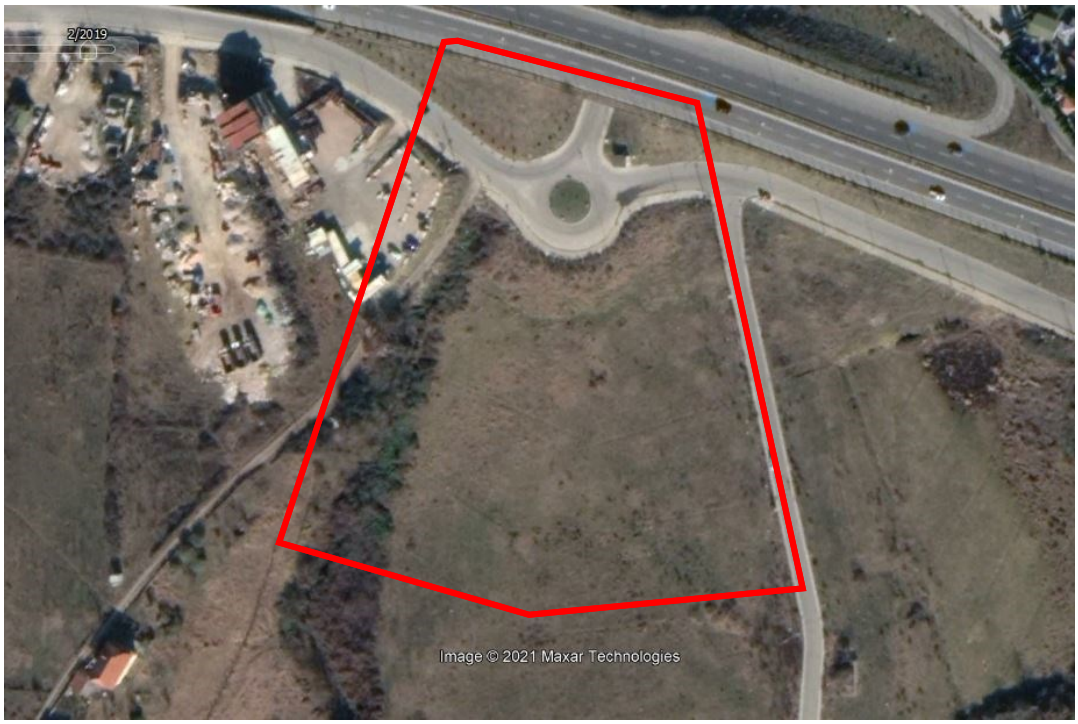


Figure 27 Arial Photo of the Area 2 extracted by Google Earth historic data 2019 by the researcher in 10.10.2021

All three selected areas are connected by the same infrastructure corridor; however, this newly build corridor was built in sequence. The first area was developed unrelatedly to the corridor since at that time the corridor had only an inter-urban corridor, but with the new corridor and the expansion of the road into

the overpass the area is developing into residential area with higher density. The second area is also located in the same corridor. This area has developed very intensively in the last decade after the infrastructure redevelopment of the corridor started. The entire section of the corridor has changed radically, focusing on high rise residential buildings, however this is something that happened before the general local plan of Tirana. The third area selected in this corridor is also in the lastly developed part of this corridor. This section was finished between 2018 and 2020, which also coincides with the local general development plan of Tirana.

This area is a completely new area, which is still under development and has just started to have inhabitants living there, which makes this an interesting find along this strong infrastructure axe.

8 CHAPTER EIGHT - INDICATOR AGGREGATION

8.1 TOD criteria and the bases for these analyses

In order to further investigate the application of TOD components in an urban context, we must firstly understand the relation of these components to the urban situation and how to apply them into an urban context. The aggregation of the components, naturally sum up the TOD theory, as the aggregation is based into the primary components of this theory.

With the thorough investigation of components relying into the IMM methodology for the translation of these components, we have matched the need for evaluating the component with the “how” is translated into a context. Starting this approach by understanding what the component is measuring, how will the measuring process occur and what data will better illustrate this component.

Starting from our first indicator “Density” as simple indicator considers only the number of people situated into a meter square area, in our case we will measure Density with the porosity of the area, including the change build volume and void in the area, the link to transportation and the functions within this area the aggregation of these data will guide this research to portray Density as the complex component it is.

The word "urban density" encompasses a wide variety of urban features and is multidimensional. Most research on urban density focus on demographics and other aspects of human settlement, which is a limitation. However, there are many

other aspects of urban density that have a substantial influence on the sustainability of cities, which will be discussed later. It is difficult to say if compact cities are more sustainable than scattered ones because of the lack of data on the link between urban density and long-term growth. City planning, development, and administration may benefit greatly from the analysis of many aspects of urban density. According to a variety of circumstances, urban density can give significant information for city planning and growth.

A city is more than the sum of its parts. Buildings, on the other hand, aren't only places to live. Densification, however, is frequently framed in terms of building as many houses as feasible and doing it as rapidly as possible. However, given that there is now a huge need for housing and the hurry to construct, it is imperative that we sit down and ask ourselves: What kinds of surroundings are we creating? Who are we constructing this for? How can we guarantee that our cities are safe, sustainable, and comfortable for all of our residents? Is the built environment and the quality of life enhanced by the new structures we are building?

The methodology chosen by the researcher is a novel design method which applies two basic principles, the measure of urban indicators happens always base on spatial data and the consideration of each component comes in a horizontal and vertical review. This process allows us to firstly address the complexity in which TOD comes as a conglomeration of many components (density, proximity to transit, mixed-us, walkability, security, permeability) but also use these components as input and output. The input components are the data we have retrieved from the analyses conducted on our three Areas for the case of Tirana, the output I this case are the data that we gain by geoprocessing this initial data into our model builder, by having two set of data with an edit value. For example, the density design for our data consideration **DENSITY = floorspace occupancy × floor area ratio × residential share × VOID of non-build area × total Volume of the build parcels × infrastructure link × Nearest transportation node within the 500-meter radius× service functions within this area** this would normally be the input data, which we will later serve as the unconventional density, but would also be the input of measuring the mixed use in the area since the density already has included the

service distribution in the area. In Figure nr. 28 we have a details connection between the theory the components and our output (grouping) of the data, conducted within this research.

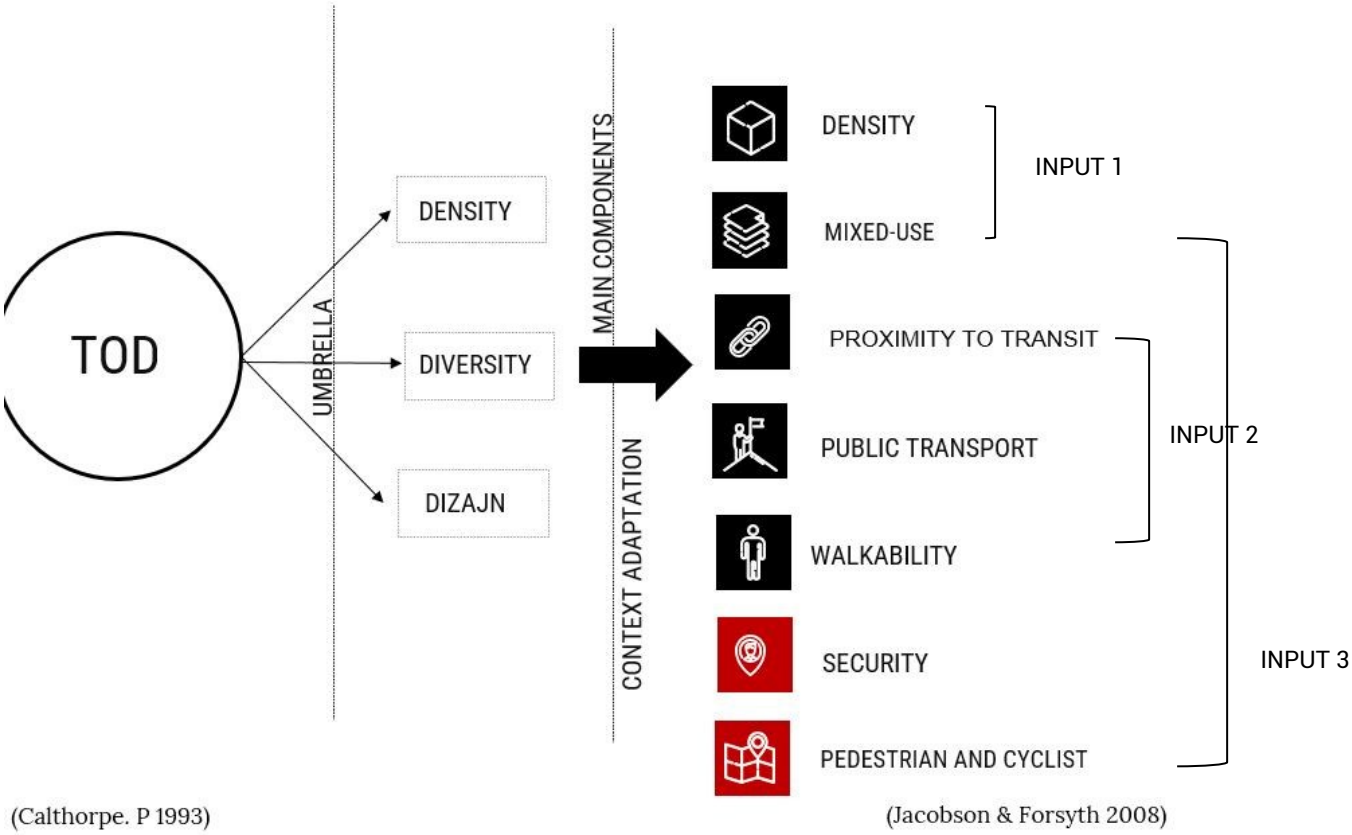
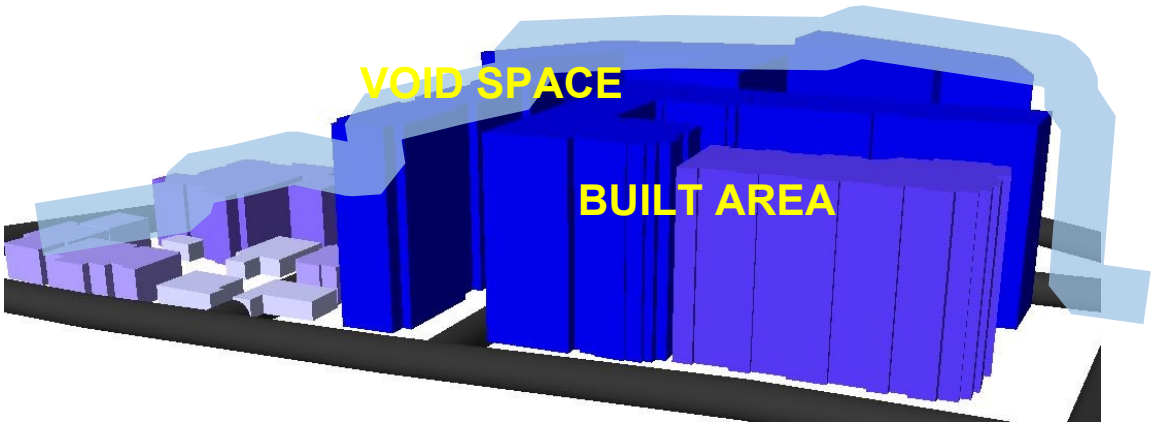


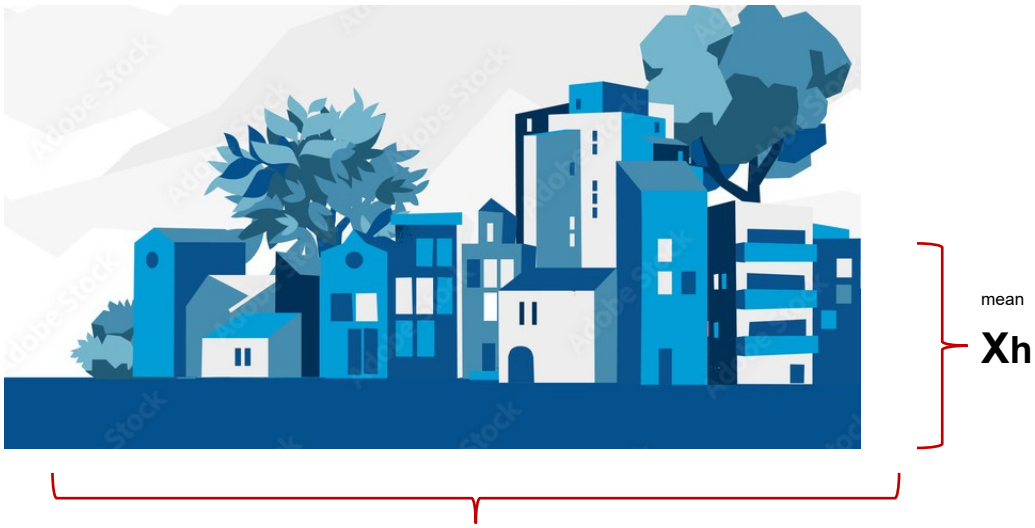
Figure 28 The main components of TOD identified in this study Source: Authors personal library

8.2 Measuring and investigating Density

Density is a vertical indicator related to the possibility of building within a space, but measuring density for this study takes into consideration the complex and vast indicators collected within an urban space. This study will measure density in relation to layer in superimposition outlining volumes in an urban context. The layer superimposition means that each layer has a different role in the key categories in

our first component is VOID / Volume / link / Transport / functions. Considering this the analyses effectuated in ArcMap model builder integrates the data of volumes, surfaces, footprint (buildings), distribution of services and the buildings number. To provide a simplified method in calculating we will use the average height of the building, covering the area to finally define the boundary of urban volume. In the classical representation of the Density the overall formula is only a collection between the **floorspace occupancy** × floor area ratio × residential share = urban density, however this representation of the formula leaves many of the urban components outside its findings. Density is necessary to understand the morphology of the city. The components as part of the TOD are much more complex and require much of the vertical and horizontal representation, taking into account not only the density as its classical representation, but also the void in between representing urban space, services within this space the distribution and linkage to the space. Breaking down the following formula:





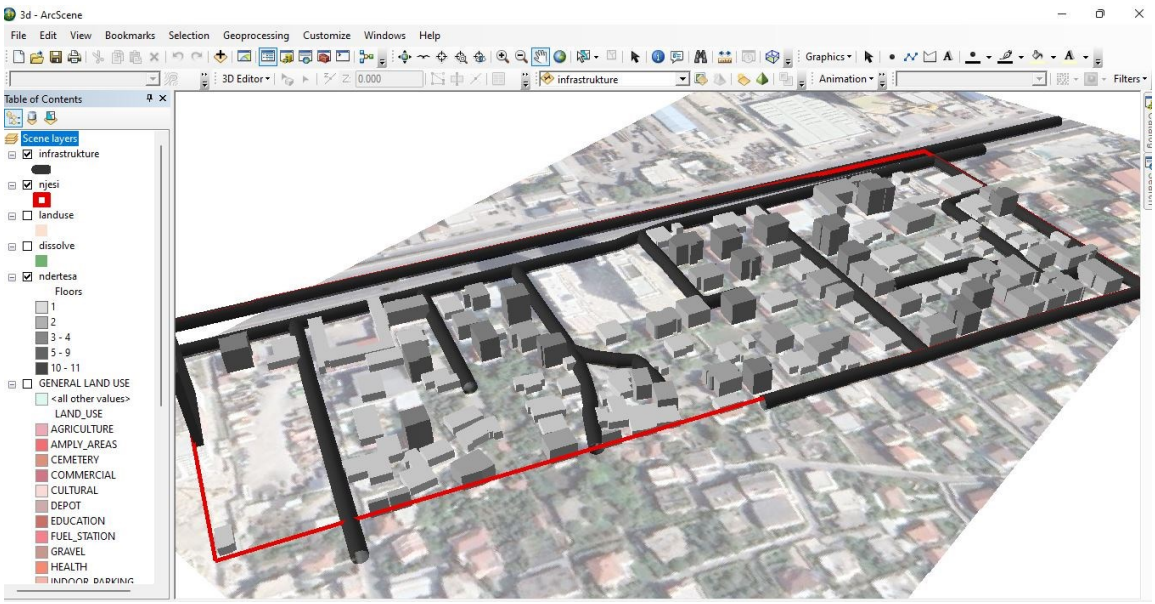
$$Xh = \sum_{\breve{V}o} (A \dot{x} h) / \sum A$$

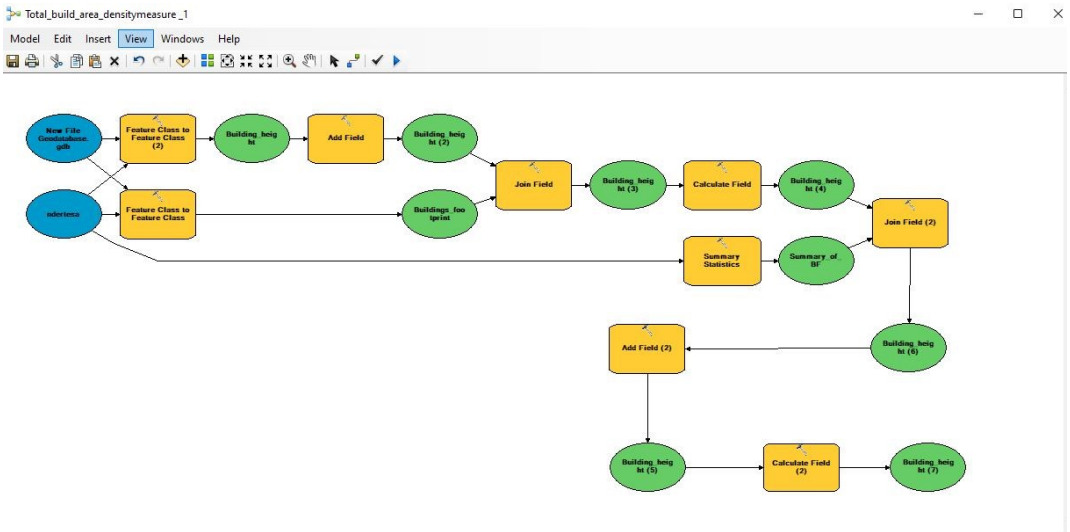
A = Area of Building footprint
h = height of building
Vo = Volume of Built area

Building footprint means the area of land measured at finished ground level that is enclosed by the external walls of a building. As a first step, we must acknowledge the current situation and understand the total volume of the area we are testing our indicators.

As a first step in generating a unified model is to create three separate files, each area must be an independent input to the model.

Area 1 calculations of the Volume of Built area:





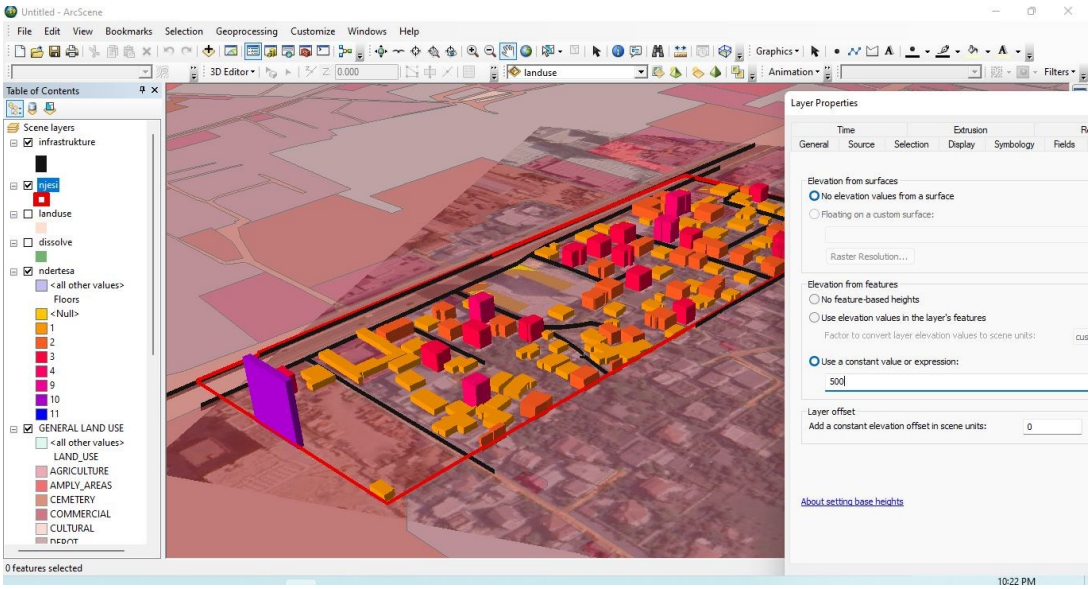
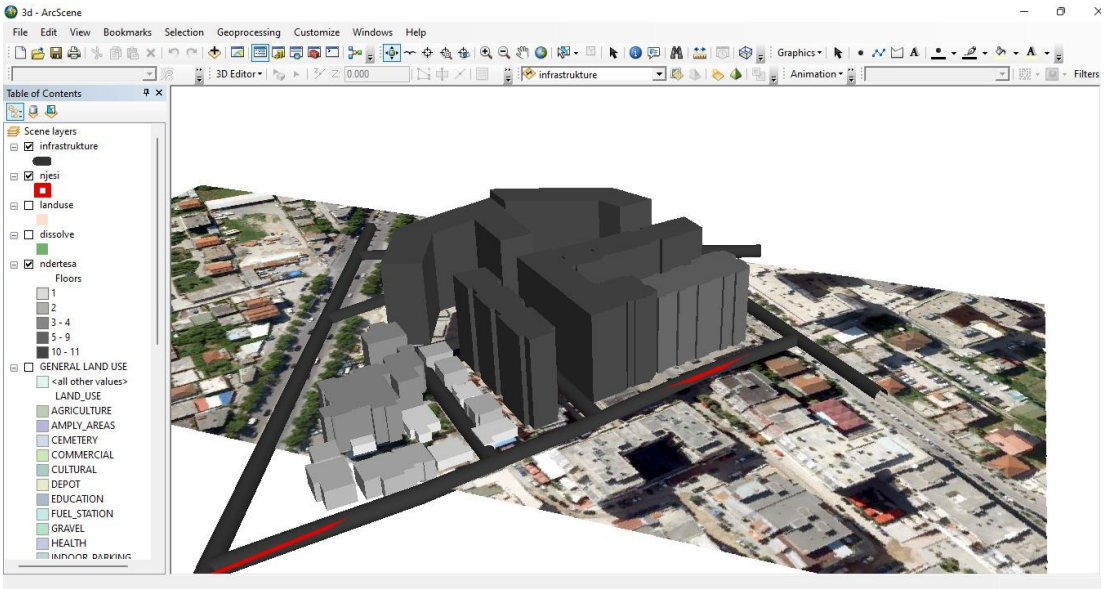


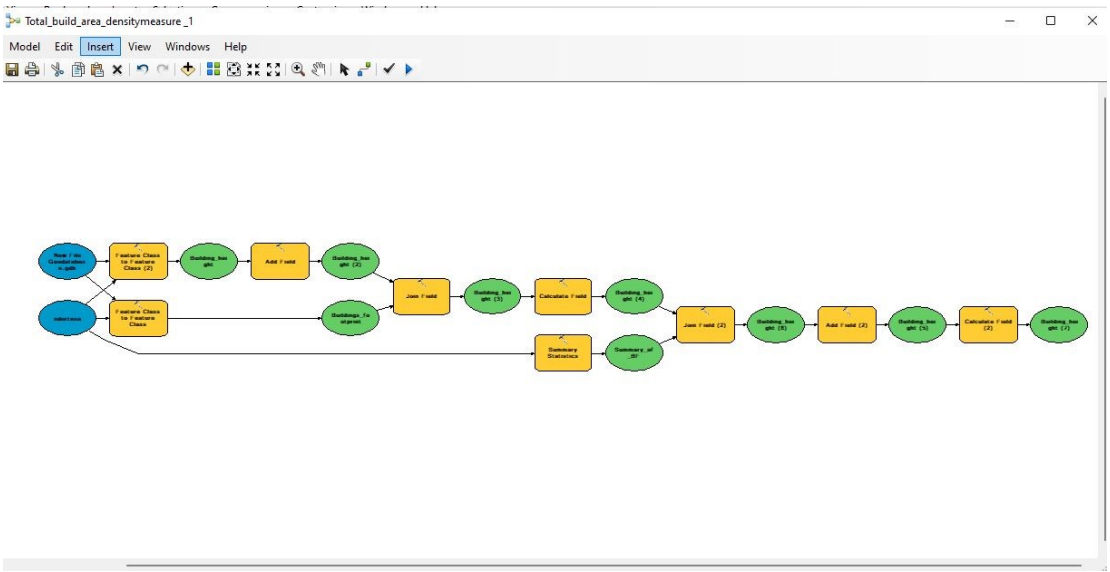
Figure 29 The formula for the total volume of the neighborhood

Calculating the total volume of built area is 1.9 for our first area

The build volume for the first area is 1.9 indexed which translates into low density in the normalization value, since it translates into as a low / low dense area.

Area 2 calculations of the Volume of Building area:



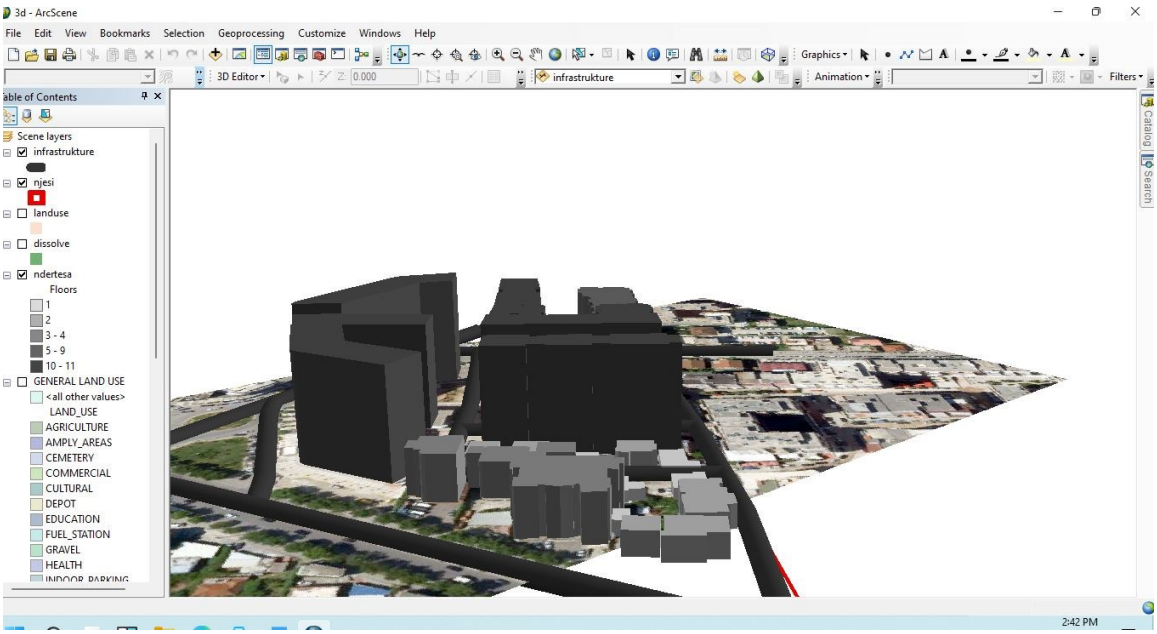


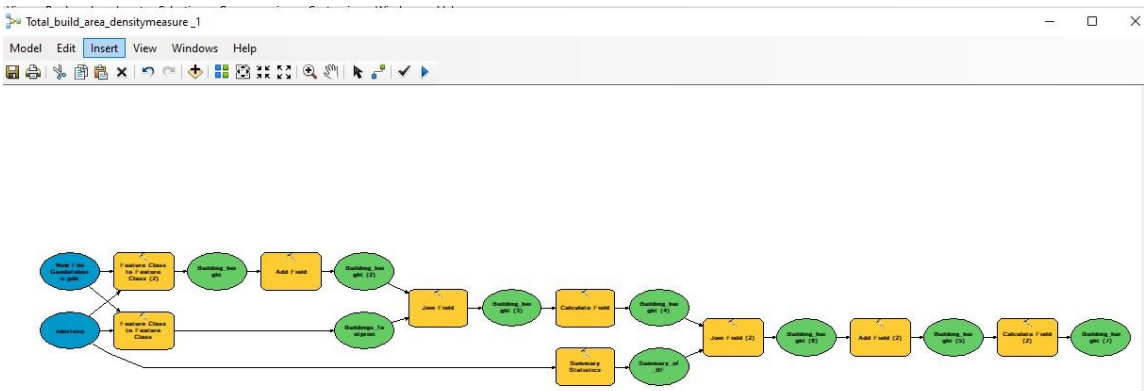
Equation 1 Model builder for the calculation of the build area which corresponds to density in our second area
Source: Authors own elaboration

Calculating the total volume of built area is 10.9 for our second area.

The second area has the build volume 10.9 indexed which corresponds to high density, however the service level is bellow 2 which leaves the area dense but not with enough services within the 500-meter radius.

Area 3 calculations of the Volume of Building area:



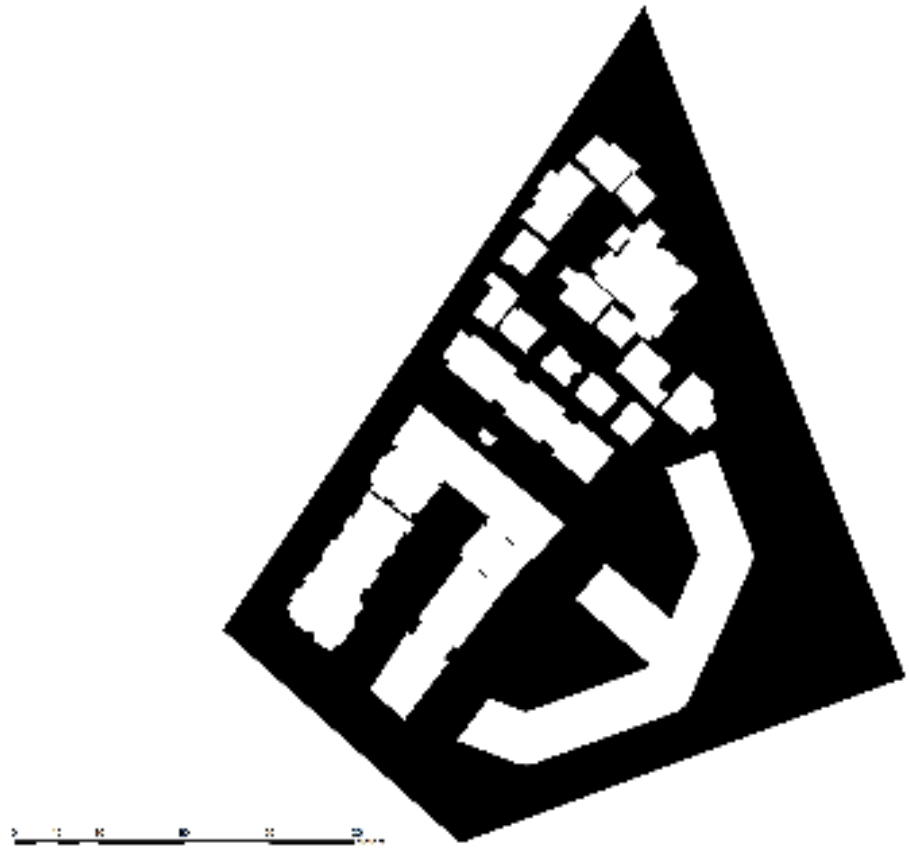


Equation 2 Model builder for the calculation of the build area which corresponds to density in our second area
Source: Authors own elaboration

Calculating the total volume of built area is 4 for our third area

The density indexed of the third area corresponds to low/mid-level density for this area, however the services in the area have scored 1.8 which is very low considering that this area has also the smallest surface of the three areas we have considered.

The volume of the area is only the first step, illustrating the measure of built area in proportion to the total area space, in a measure of build and void.



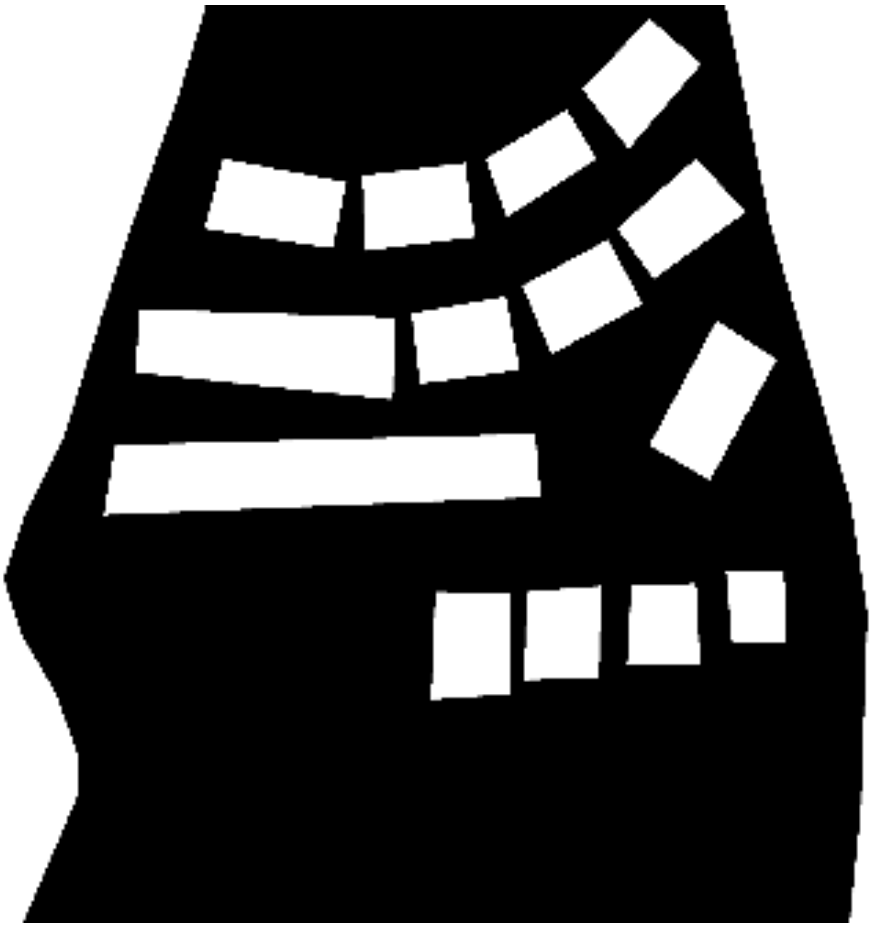


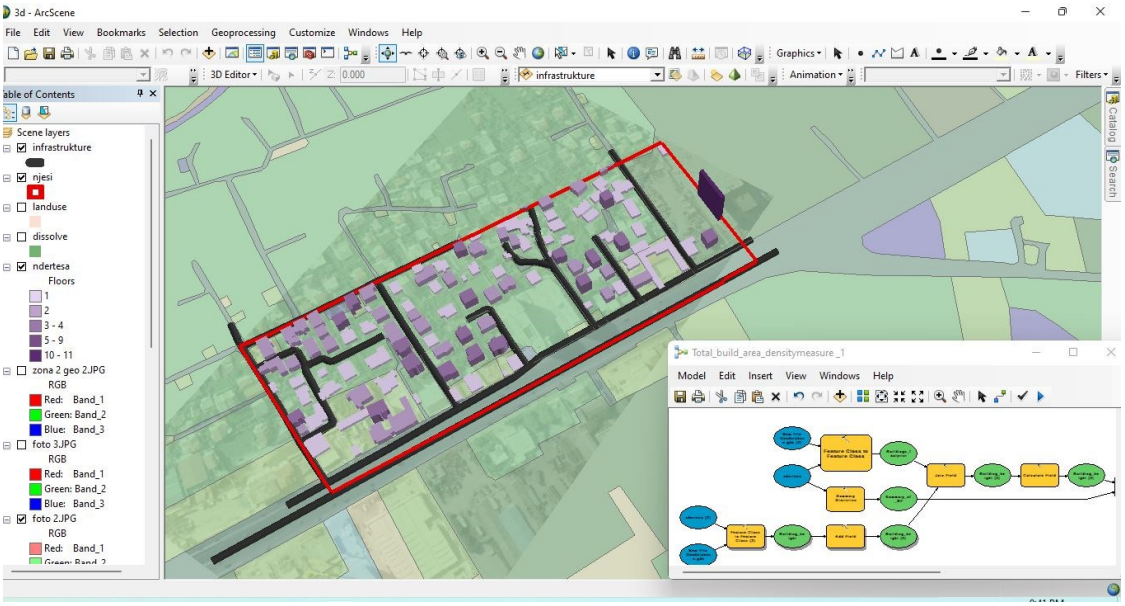
Figure 30 The illustration of Void and Build area for our test sites illustrated by ArcMap / Arc scene Created by the Author

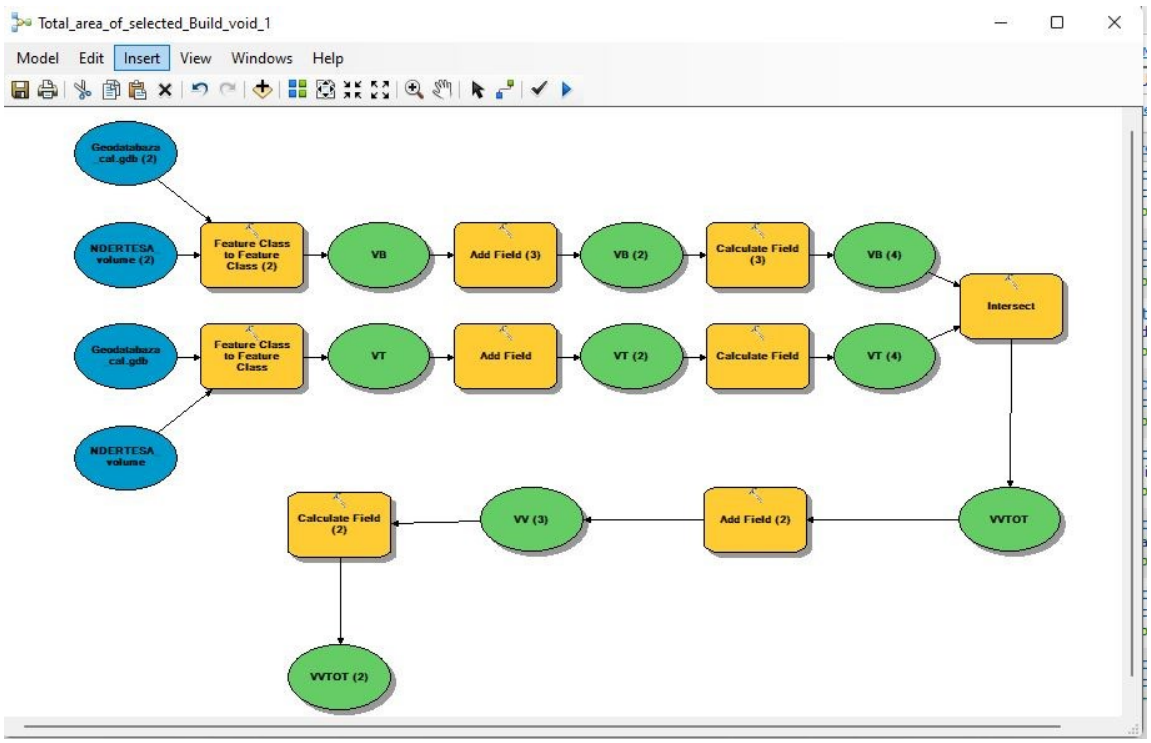
After obtaining the first part of this formula, we will find the total volume of our neighborhood. After calculating the volume of built area in this second part of this formula, we can easily calculate the volume and void of the space in a percentage ratio.

Calculate the volume of built space (**Vv**):

$$\left.\begin{aligned} Vt &= At \times Xh \\ Vb &= \sum (Axh) \end{aligned}\right\} \quad Vv = Vt - Vb$$

Vt= Volume of the site
Vb= volume of the buili area
Vv= void space volume
A = Area of Building footprint
At = Total area of selected site
h = height of building
Ps= porosity (%)





Calculating the volume of built space for area 1: **156868.99- square meters**

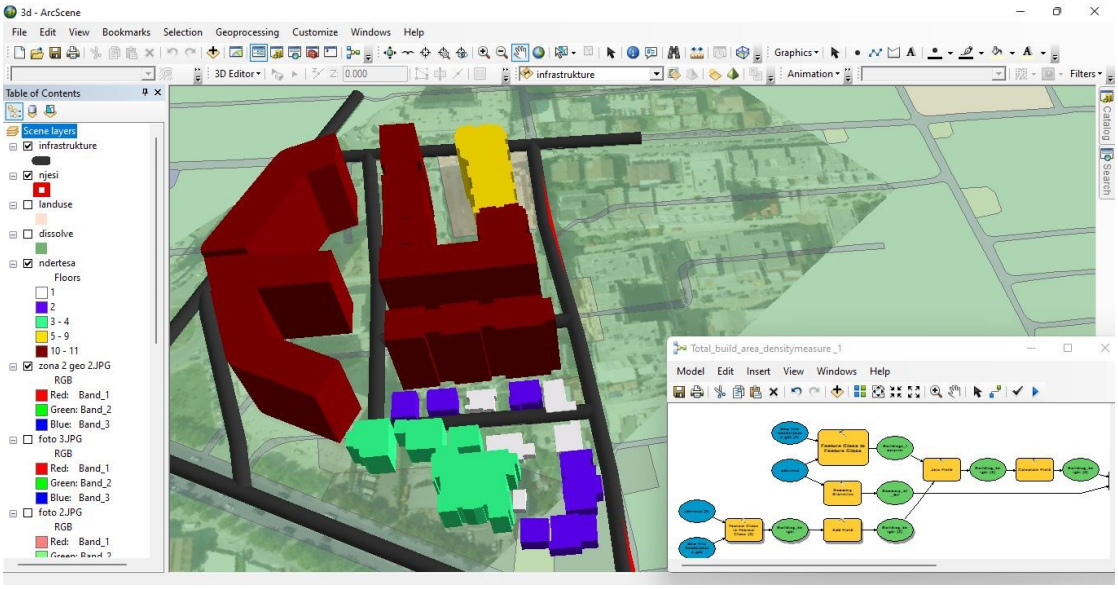

3d - ArcScene
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Table of Contents
Scene layers
infrastrukture
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dissolve
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1
2
3 - 4
5 - 9
10 - 11
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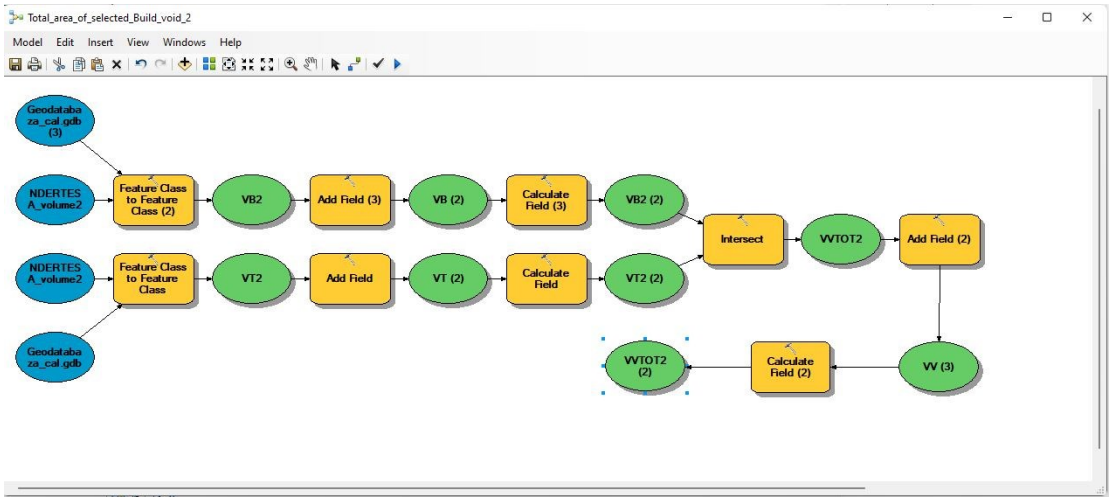
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NDERTESA_volume2
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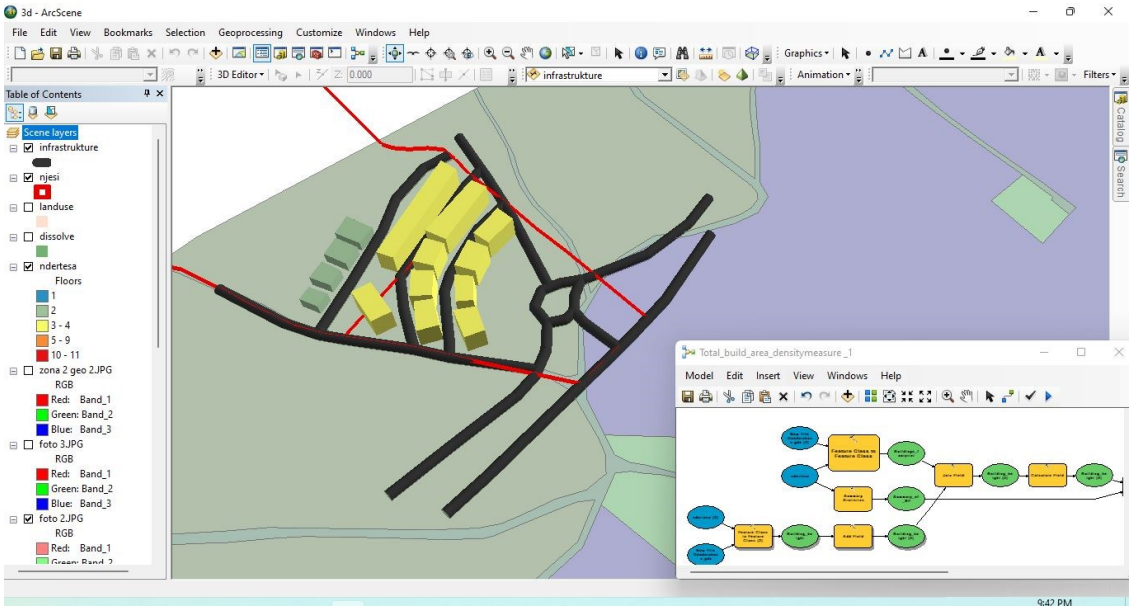
VT (2)
Calculate Field
VT2 (2)
Geodatabaza_cal.gdb
VVTOT2 (2)
Calculate Field (2)
VV (3)

Calculating the volume of built space for area 2: **382896.98- square Meters**



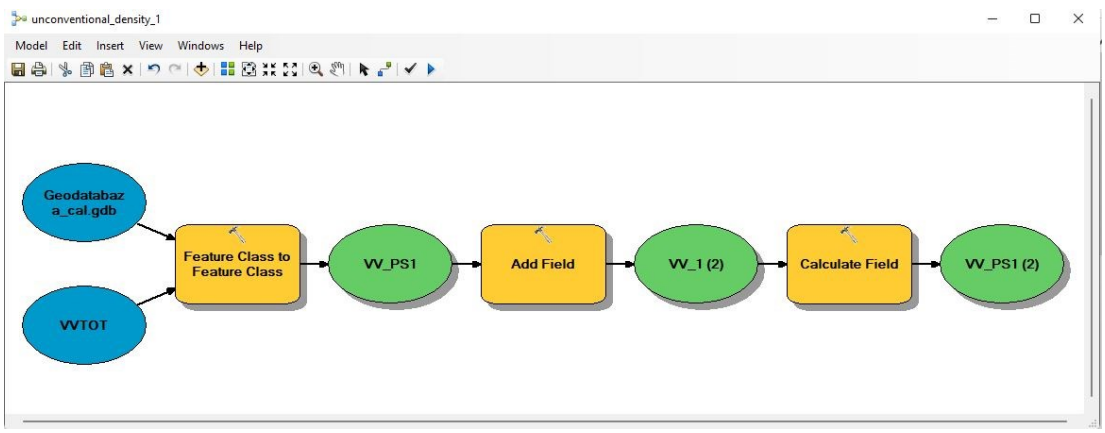
Calculating the volume of built space for area 3: **56970.21-meter square**

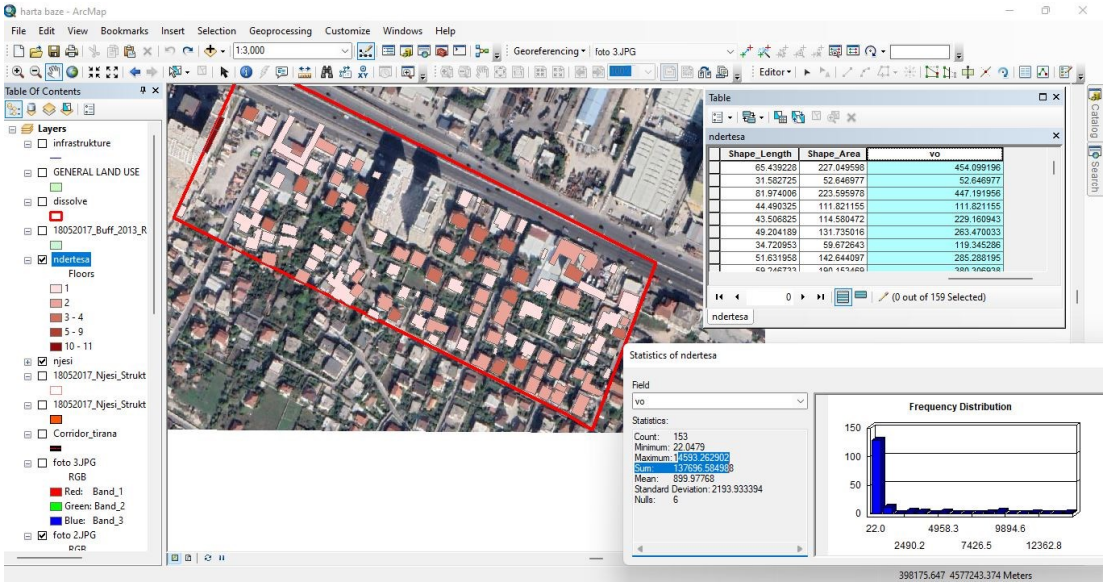
And finally measuring our unconventional density, therefore, density of buildings and the density of build void space through:

$$Ps(\%) = Vv \,/\, Vt$$

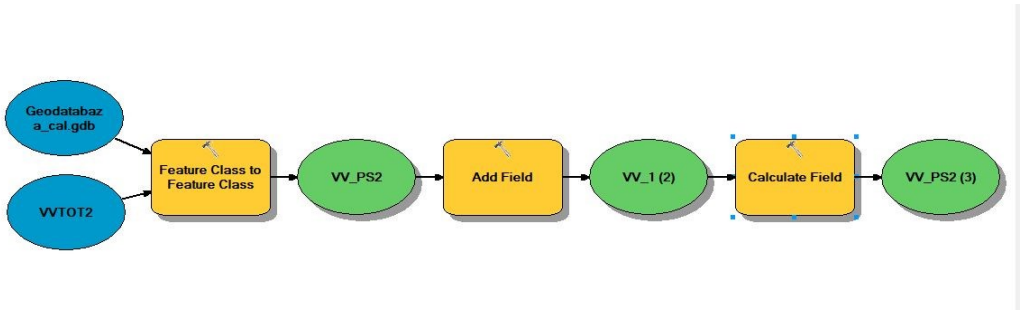
The measurement of the unconventional density considers the volume building and the volume and void of the area, in order to establish the Density of the area.

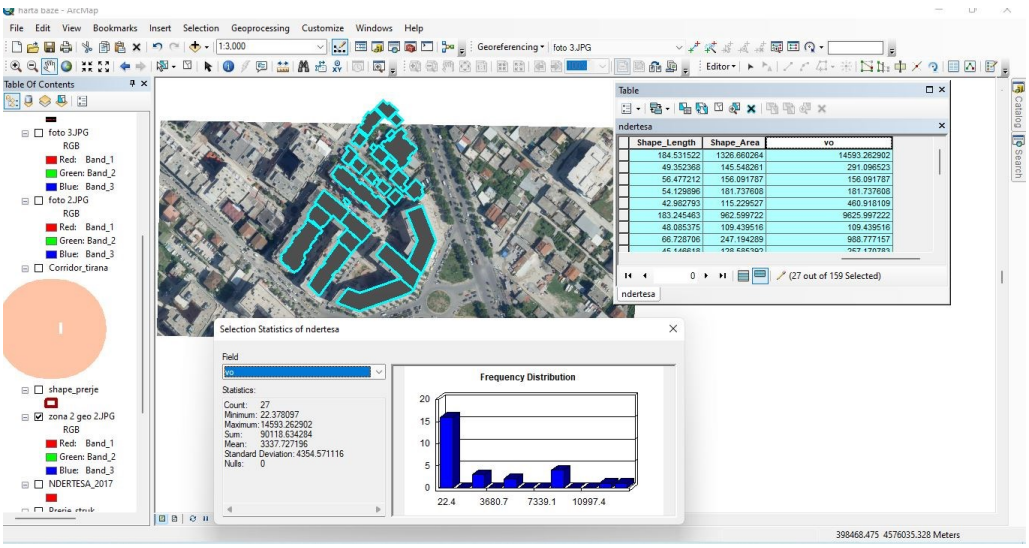
Density of area 1 = **82 %**



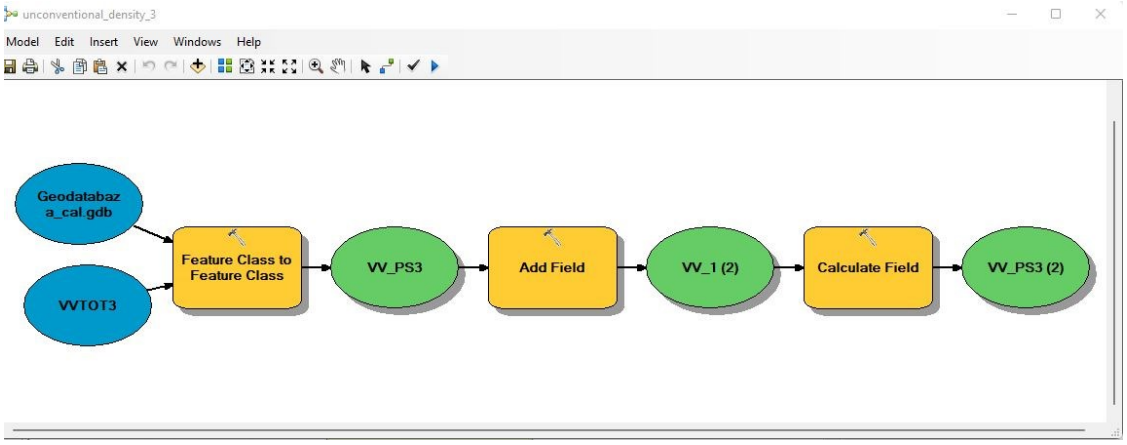


Density of area 2 = **68 %**





Density of area 3 = **66 %**



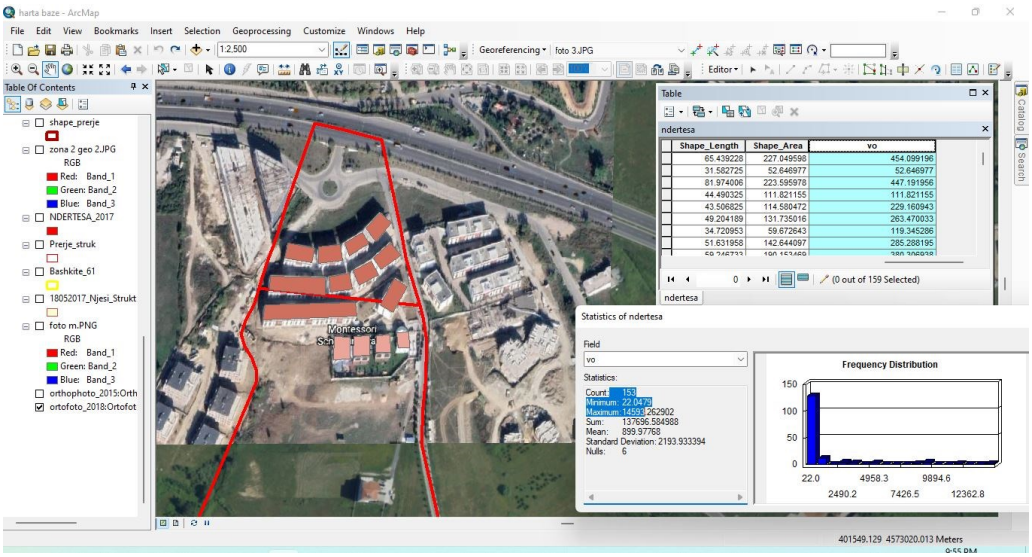


Figure 31 The representation of the volume, two cases of the same volume represented into the example

In this study we have found that Density should be considered in relation to the volume, however in the above representation, we understand that this is not the case, because a volume influences Density qualitatively. For this reason, we consider the horizontal elements that influence indirectly density in the calculations bellow.

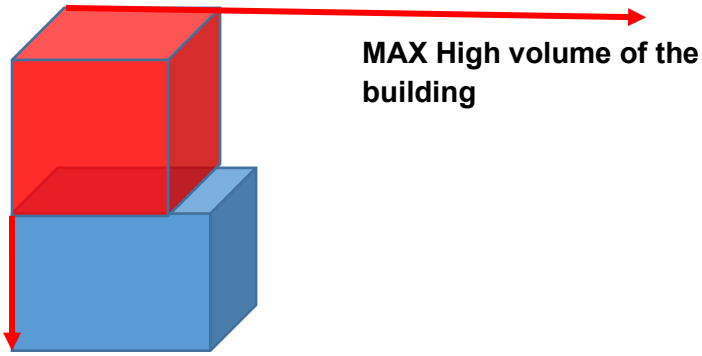
Defining the calculation of density in the city considering surfaces, our calculating method broadly considers the total area surface of the buildings and the sum of the total free area and make a ratio between the two for the total analyses area.

The calculation expands into surfaces:

$$Sr = \sum (P \ x \ h)$$

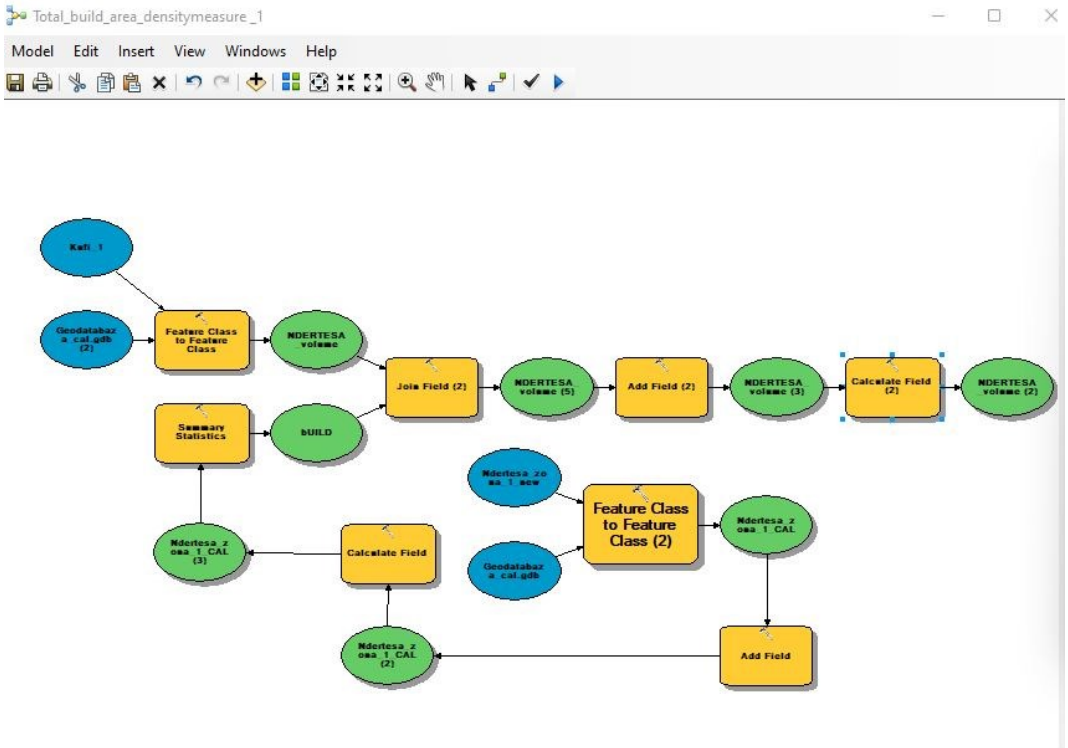
$$At = Ab + Av$$

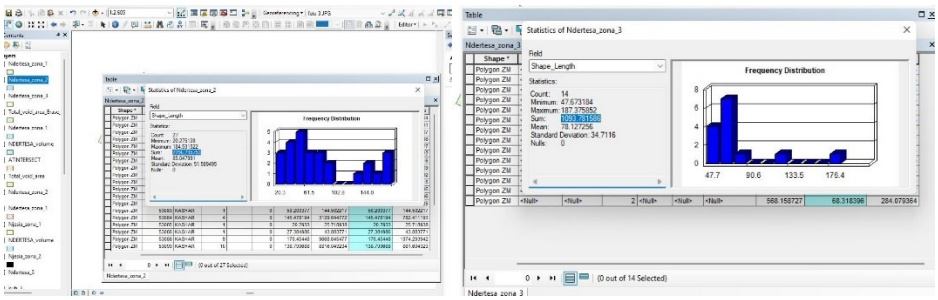
Ab = total area of Building footprint
Av = total void area
h = height of building
p = Building perimeter
Sr = Free vertical space of the building
At = total area of analysis



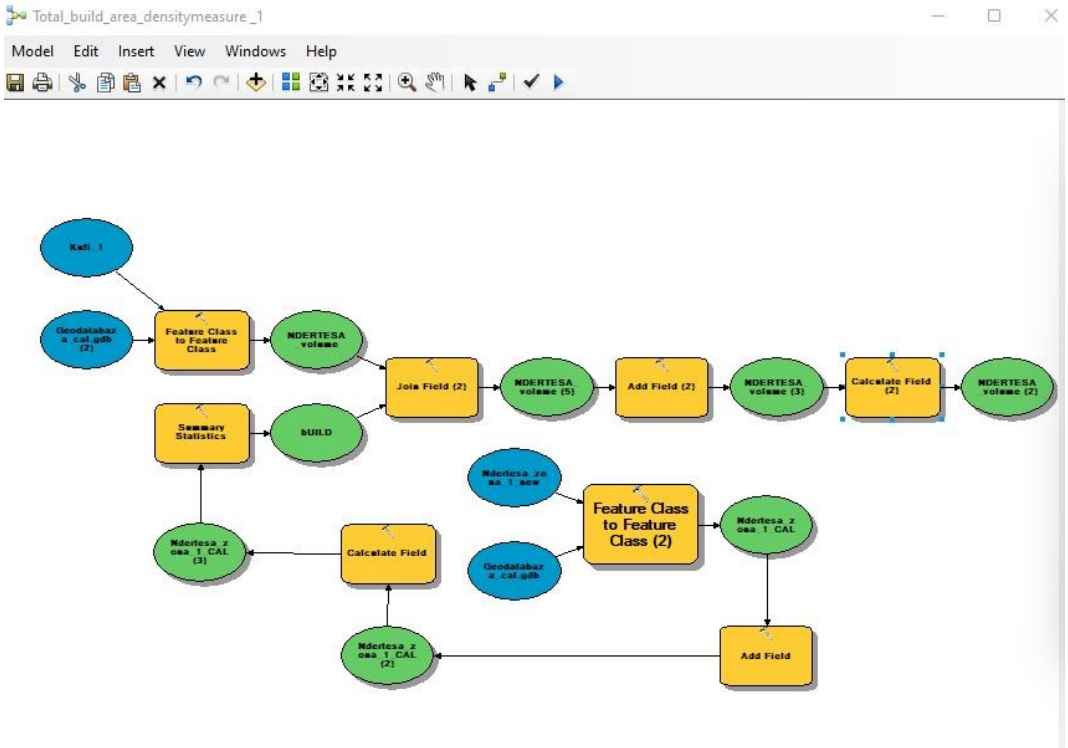
The calculations for the first area:

In our first area the total height of the building as a data extracted by the calculation, however the free vertical space, in our case will be the data extracted by the Local development plan which establish the FAR and the max height of the buildings. In the first area the max floor heigh its 10 floors.

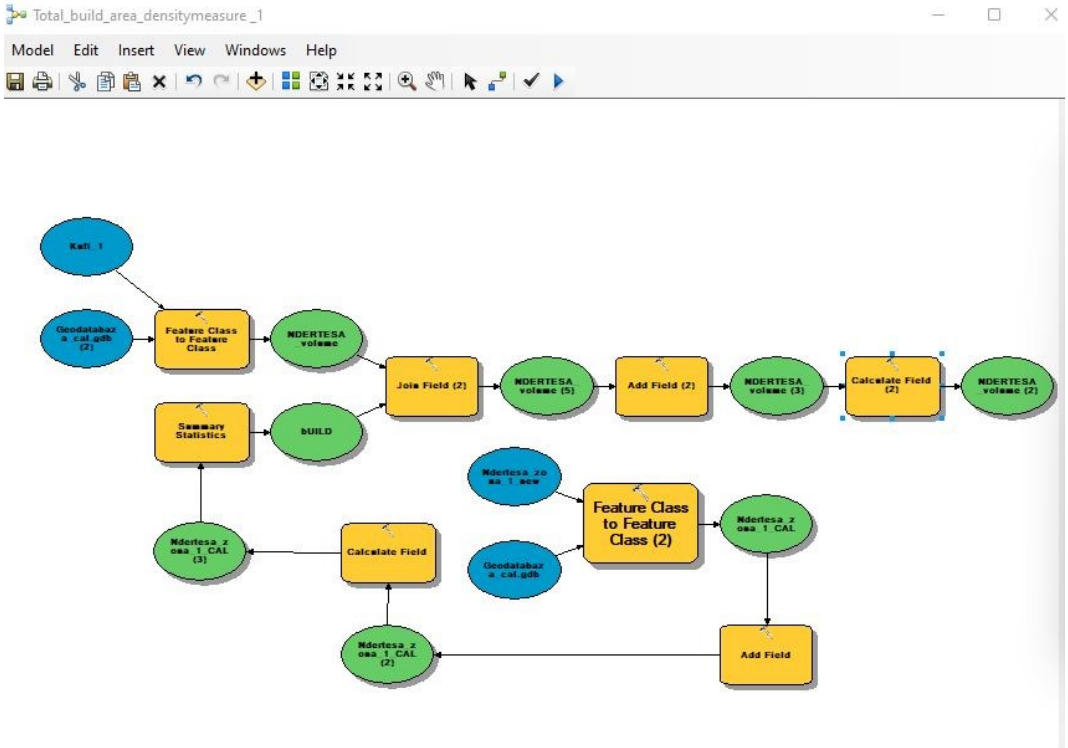




The free total area and total area of the analyses is equivalent to: 37708.4 for area 1



24928.64 for **area 2**

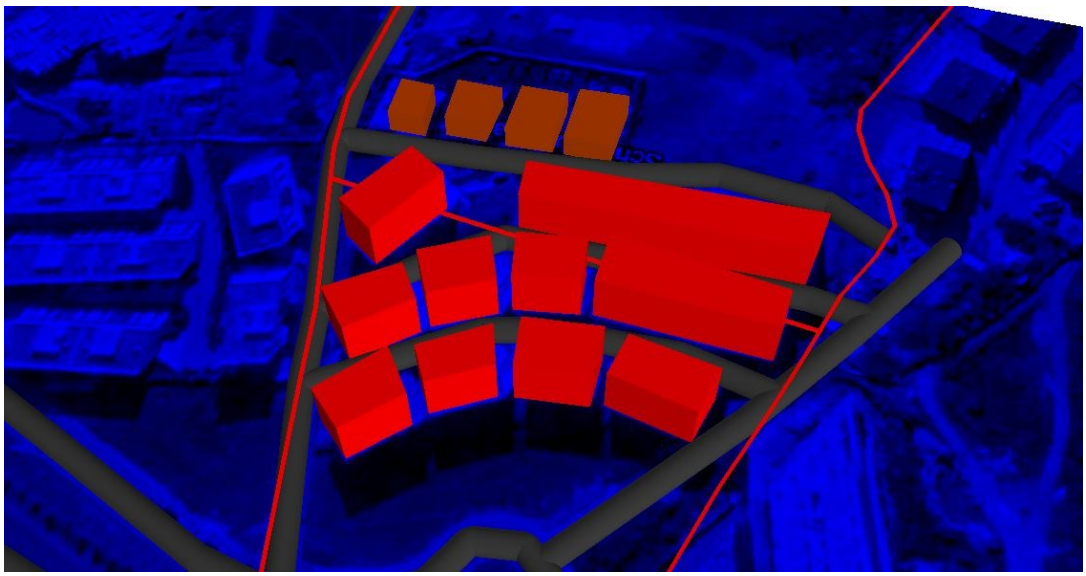


and 6179.81 for **area 3**

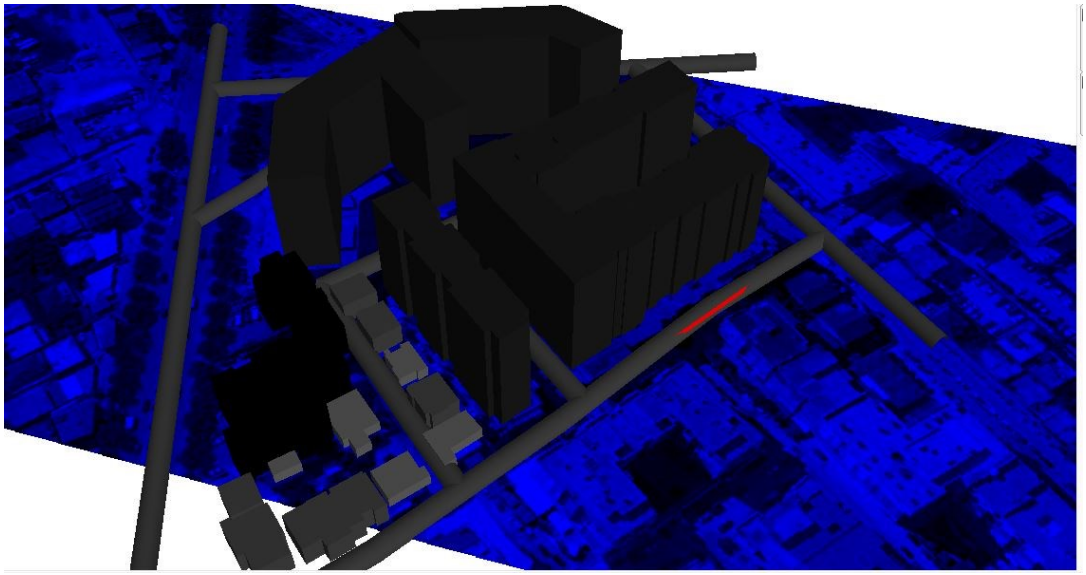
This will finally allow us to apply the formula of the surface.

As a final step is that the formula can apply the formula surface ratio giving the percentage as follows:

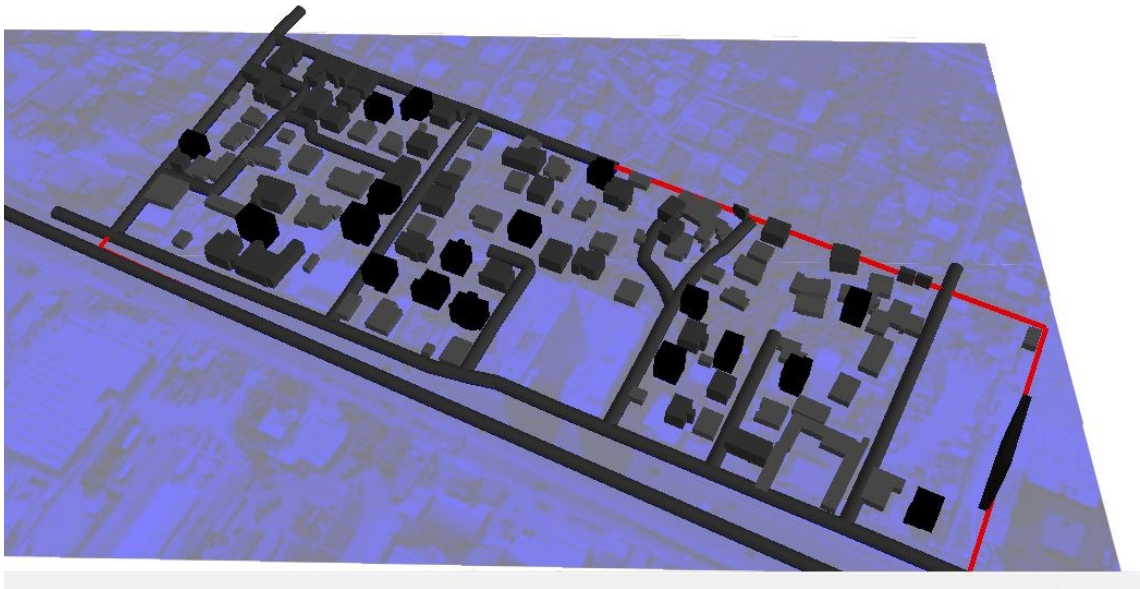
$SURF(\%) = (Sr \,/\, (At + S))$



Total surface area for the is 45%



Total surface area is 60 %



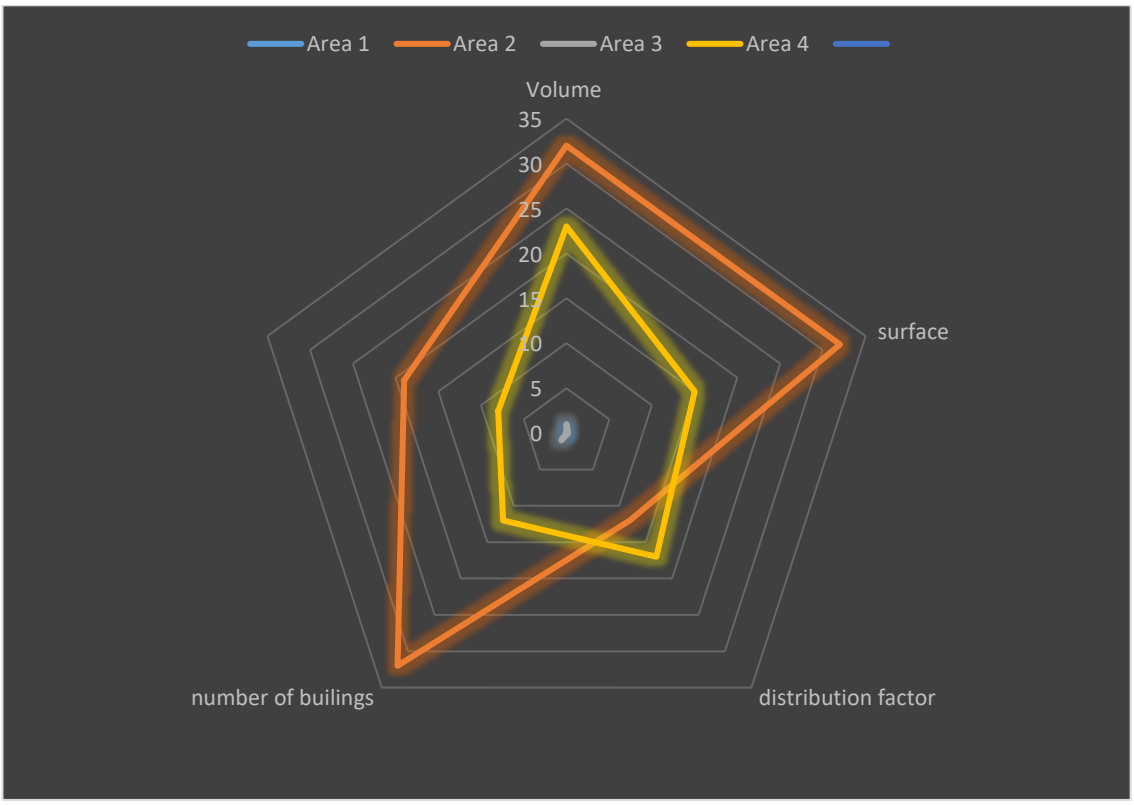
Total surface area is 40%

Measuring coverage and gross floor area ratio:

$COV(\%) = Sground \ / \ At$

$FAR(\%) = \frac{(Sground \ x \ Nfoor)}{At}$

Applying our measures to the selected area of our study, the final findings will be compared with the case studies from the American and European prospective.
As these studies have been selected as successful cases. The finding will help us establish the missing components of TOD parameters.



In the Density (porosity) spectrum diagram above the case studies outcomes measured by breaking down the calculation of the density, within each element has been attributed the findings of the automatization in Arcmap. The variation of the findings shows that area 2 and area 4 have a disproportion in the number of buildings and the total surface of the area. These findings clearly show that the area has a low distribution of services in attribution to the surface and volume of the area. This clearly shows the gap within this first parameter.

8.3 Measuring and investigating proximity to transit

In order to measure the proximity to transit in a classic scenario we would only divide the area into a grid of 15x15 (we could easily use the grip provided by the institute of statistics which can be found in:

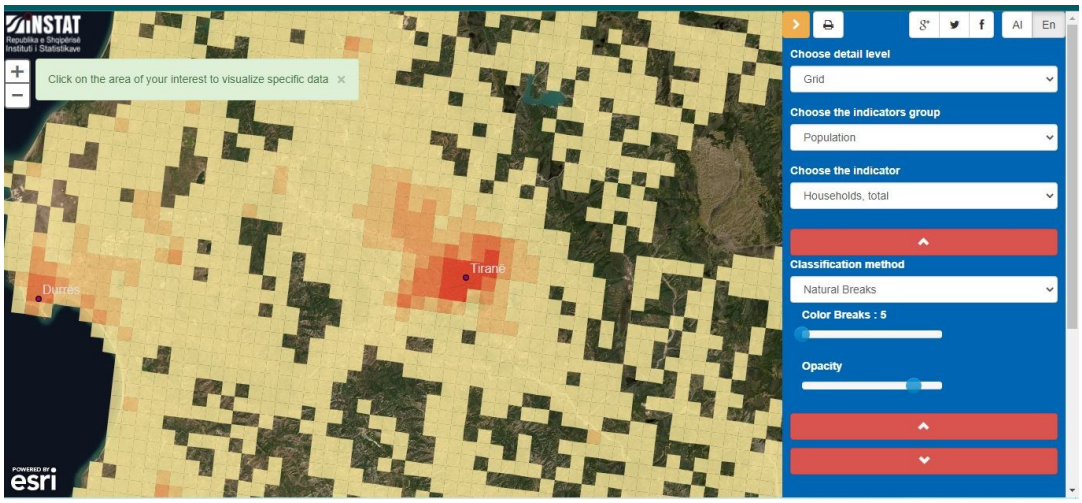


Figure 32 Table of grip division of the territory established by the institute of statistics of Albania in 2017 Source; Institute of Statistics open source Webgis platform

https://instatgis.gov.al/#!/l/prefectures/population/prefpop1) as measure of distance and usee it as a base to identify the stations. From there, the second step would be to establish the area of walkability according to the 500-meter established by this study in the theoretical part. However, we will consider this parameter as a more complex filter, using not only the horizontal analyses but the vertical as well. Firstly, we establish the intermediate scale which we defined as our area of study, then we locate all the built volumes in the area adding the bus stops, taxi stops and bike stations. We continue by adding the comfortable walking area which we have established in the research (500 meter). By overlaying these two pieces of information we can easily understand the high-density walkable areas and the areas with low walkability. The outcome of this analytical process will be established in a measurement grip (to help us understand the translation of the coverage of built, void and transport better). More on this can be viewed into the picture:

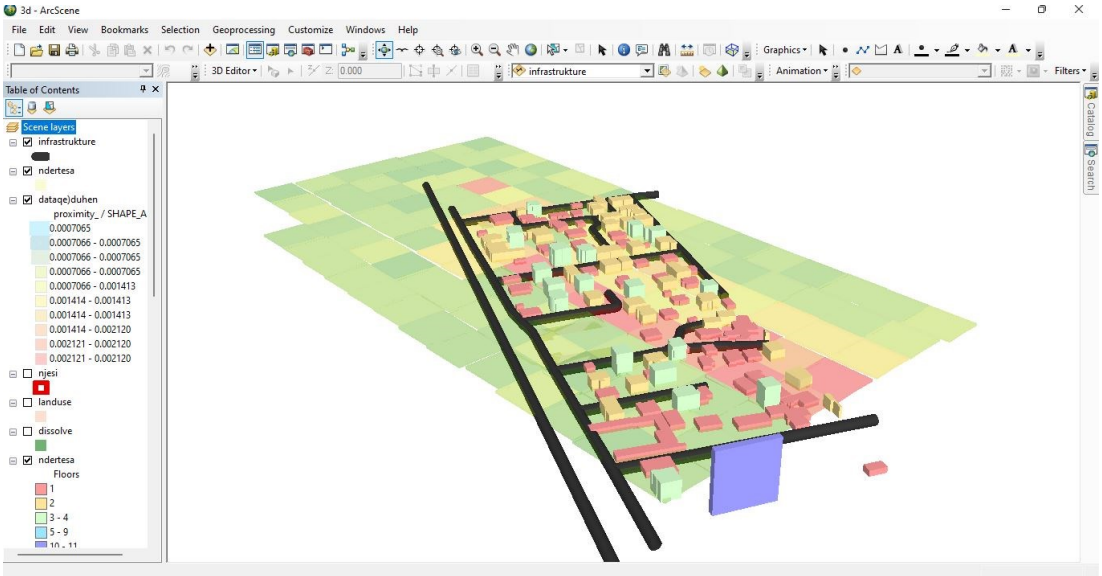
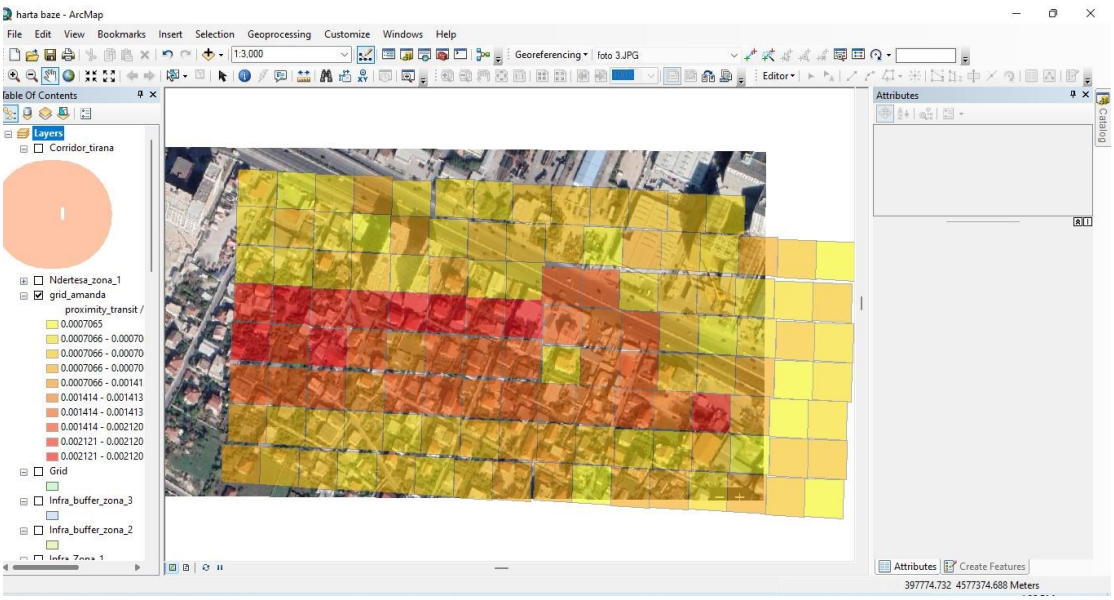


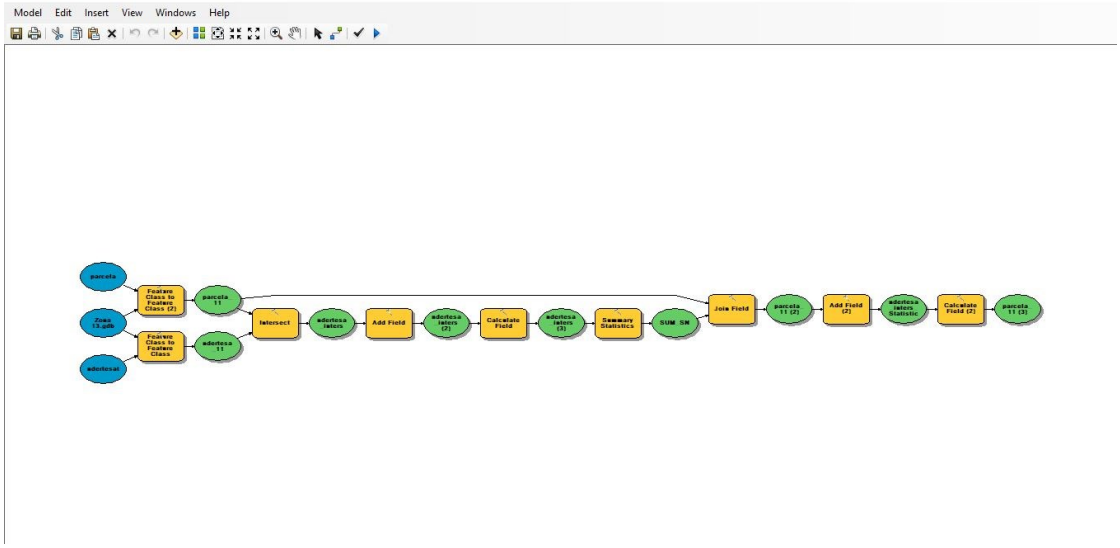
Figure 33 The overlying of the build, void and transit areas in our case

With this map outcome we can observe what is the number of buildings that have a high density with low accessibility and what buildings have low accessibility, also high accessible areas with no built volume, which as a result become areas were future development can occur. Calculating the overall proximity to transit and how effective this proximity is within the area we use:

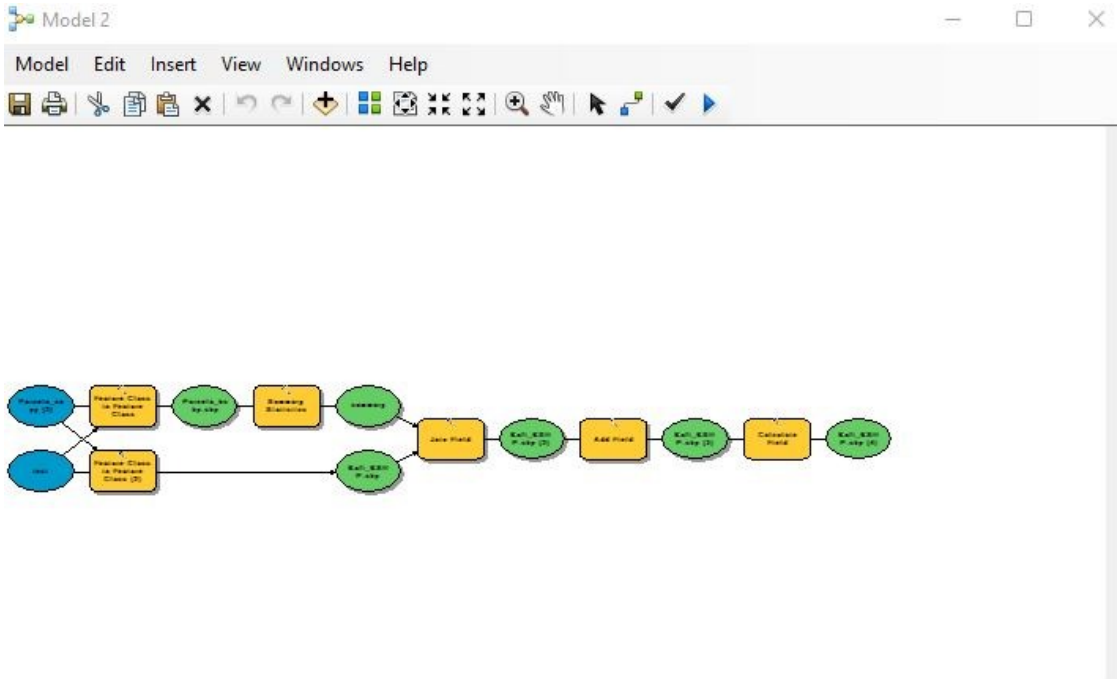
$$Ef = Np \,/\, Nt$$

Np= Number of Trips in Public transportation
Nt= Total number of Trips





The data measured in the table below belong to the data field by the researcher during the two different times of observation. The first observation happened in the interval of two hours from the 11:00 am to 13:00 pm on June 20th 2020, in the two intersections of the area. The second observation took place between 9:00 am and 11:00 am at the same intersections on 21st November 2021.



Table

Ndertesa_zona_1

Shape *	OBJECTID *	Floors	Shape_Length	Shape_Area	public_TRANSPORT_trips
Polygon	1	2	65.439228	227.049598	454.099196125691
Polygon	2	1	31.582725	52.646977	52.6469765468243
Polygon	3	2	81.974006	223.595978	447.191955979991
Polygon	4	1	44.490325	111.821155	111.821155407912
Polygon	5	2	43.506825	114.580472	229.160943406199
Polygon	6	2	49.204189	131.735016	263.470032712629
Polygon	7	2	34.720953	59.672643	119.345285828044
Polygon	8	2	51.631958	142.644097	285.288194626519
Polygon	9	2	59.246733	190.153469	380.306938276389
Polygon	10	2	51.535215	149.340555	298.681110290586
Polygon	11	2	52.796126	170.761286	341.52257292323
Polygon	12	2	39.492158	97.449882	194.899763997387
Polygon	13	3	46.838655	127.75568	383.267038788574
Polygon	14	3	55.062918	152.720844	458.162530987588
Polygon	15	1	52.272304	153.223281	153.223281345998
Polygon	16	1	49.492395	131.721839	131.721839354526
Polygon	17	1	29.430225	54.074663	54.0746625063607
Polygon	18	1	19.617852	22.0479	22.0479002490697
Polygon	19	2	48.730764	147.627327	295.254654830745
Polygon	20	2	77.627123	281.148576	562.297151476862
Polygon	21	1	46.026412	132.363829	132.363829312106
Polygon	22	2	54.930832	160.440639	320.88127818706
Polygon	23	1	74.905942	292.009156	292.009156459581
Polygon	24	2	30.663037	58.651438	117.302875237479
Polygon	25	1	56.235282	168.856774	168.856774467016
Polygon	26	1	43.530229	116.92064	116.920639878878
Polygon	27	2	57.44942	179.519451	359.038901466748
Polygon	28	1	40.594412	101.282878	101.282877713963
Polygon	29	1	37.423802	83.687083	83.6870832470311
Polygon	30	2	40.588084	96.463345	192.92669013839
Polygon	31	2	43.214105	113.992593	227.985185837759
Polygon	32	1	52.012675	140.086942	140.086941782797
Polygon	33	1	37.135006	78.45824	78.45823963554
Polygon	34	1	20.046894	23.833814	23.8338138497596
Polygon	35	1	42.533793	112.210101	112.210101038995

0 (0 out of 118 Selected)

Ndertesa_zona_1

Table 12 The observation for the proximity to transit and fluxes represented by the authors findings

Translating these parameters in urban planning models aided by ArcMap is not an easy task. For the translation of this model, we had to overlay existing information from the database offered by the local development plan. This data is accessed by the ASIG[11] which is the institution in charge of data aggregation and management at country level. These data are free to use, but with restricted access to changes and alterations. The translation of the formula into a model that can be used and operated independently by only altering the input, considering the logical road to the conclusion of the data which in this case is the formula:

[11] *"ASIG is focused on presenting the geospatial data and services provided by the responsible public authorities, as defined by law no. 72/2012, "On the Organization and Functioning of the National Infrastructure of Geospatial Information in the Republic of Albania".* Https://geoportal.asig.gov.al/en

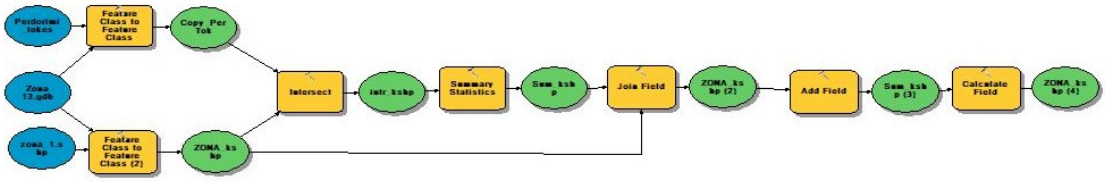
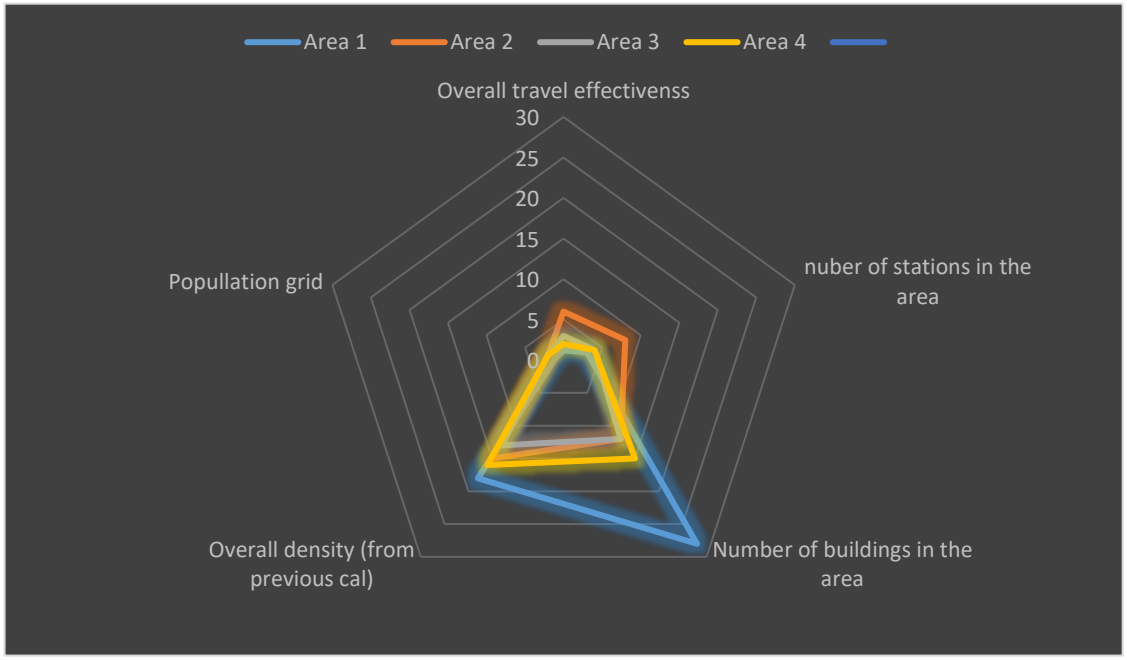


Figure 34 Model builder for the measurement of effectiveness part of the proximity to transit analyses Source: Autor's findings from the application of the formula in ArcMap



From our findings there are some preliminary conclusions related to the high number of buildings in our three areas, unproportionally to the number of stops and transit lines. This gives some clear indication of the planning of the area and the need for a better coverage of the accessibility to transit stops in comparison to the density and buildings in the area.

8.4 Measuring and investigating Mixed use

The classical approach to mixed use would consider this indicator either at the isolated building level, by understanding the percentage of services allocated into a single building or it would simply identify the overall percentage of the services in the area and make a simple deduction on the areas surface. In our case we

incorporate the volume, built environment and the function layer considering the key functions of the area accessible by walkable distance in accordance to the 500-meter distance we have established. The step followed by this indicator measurement is to establish the built area which in our case will be extracted from the built volumes that we identified in the measurement of proximity to transit, when the key functions through the land use cover provided to us by the database of the local development plan of Tirana city, overlaying the buffer circles of 500-meter of walkable space to reach transit stops defined into the proximity to transit parameter and finally analyzing the outcome of the map identifying the areas of mixed uses in comparing to service, build density and transit.

In order for our data to be centralized in this study the key functions will only consider these categories: education (Schools, kindergartens, daycare, universities and educational spaces), administrative services (documentation office, municipality etc.), entertainment, commercial and business. The scale of applying these principles will remain the same by considering the administrative division of the smaller division unit accepted into the plan in our case (administrative unit borders defined by the Plan).

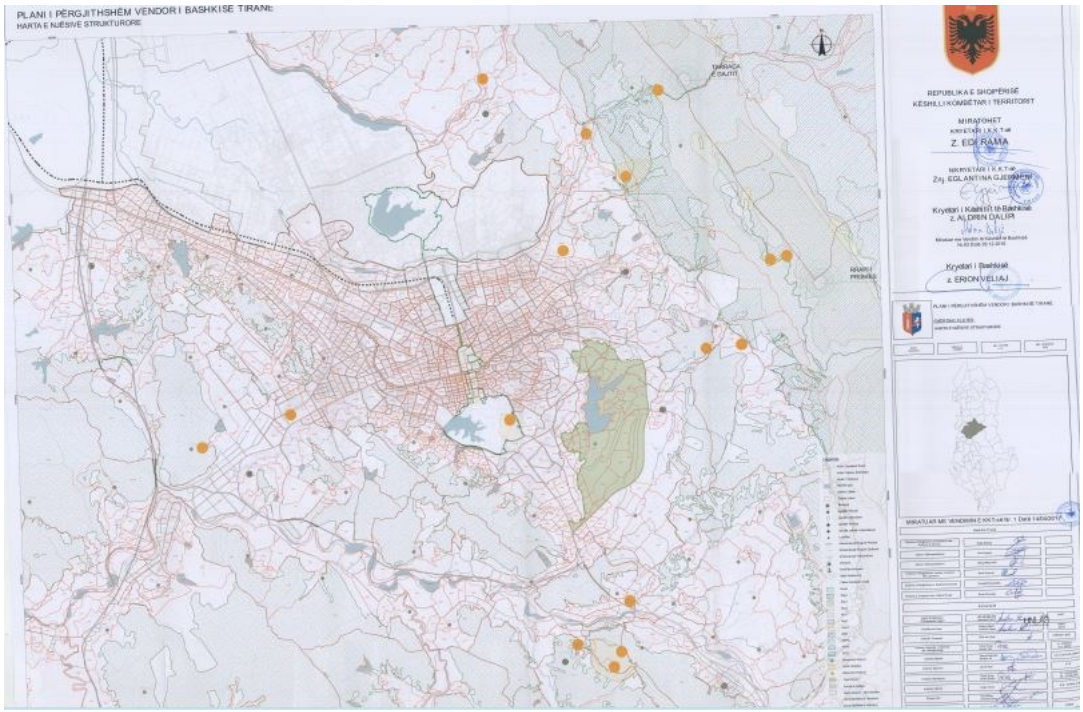


Figure 35 Map of Tirana for the Administrative planning units in 2019 national plan Source: National Planning Agency document 2019

Measuring the mixed use within the indications explained for our case studies is done by the formula:

$$P_x = \frac{\sum_{i=0}^{N} nf}{N} \qquad P_x = \frac{\sum_{i=0}^{N} nj}{N}$$

Nf= Number of functions
Nj= Number of jobs in the walkable distance
N= Number of circles by (walkability)

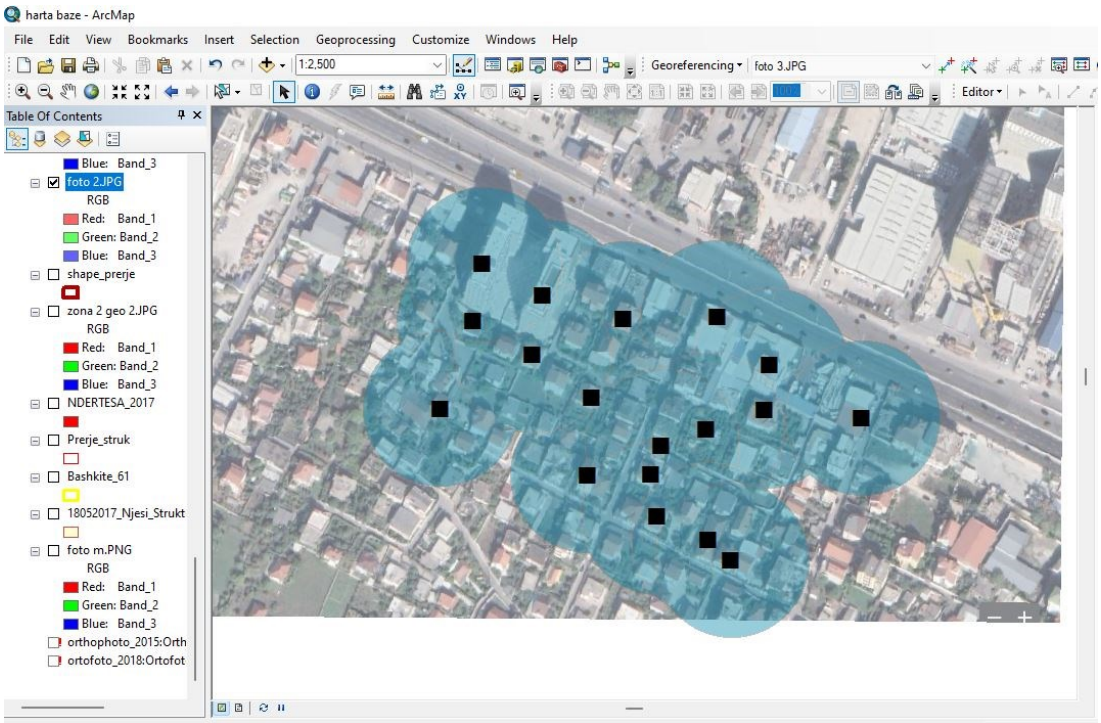


Figure 36 Data overlay on the mixed uses on the area using the superposition of the main services

As the data shows, the overlay on the main services divided by our main categories in the area, the stops and the proximity to transit mainly paint a picture of the dense services in the area mainly into the outskirts of the area leaving some of the inner area with no service. However, inputting a second layer in this equation would mainly explain the lack of services in the open space area and public space with no use, this serves as a first observation for the creation of shared space and incorporating services in the areas were the map shows deviation. Finally, translating this indicator into a reusable tool suing model builder, as a reminder that the model can be adjusted through input, so the new area or a city, considering this

model, can implement the same method and model, changing the number of inputs in the model:

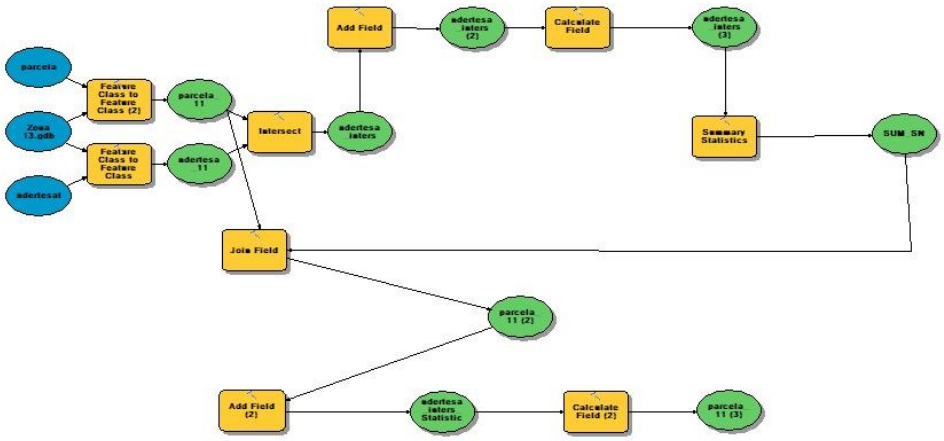
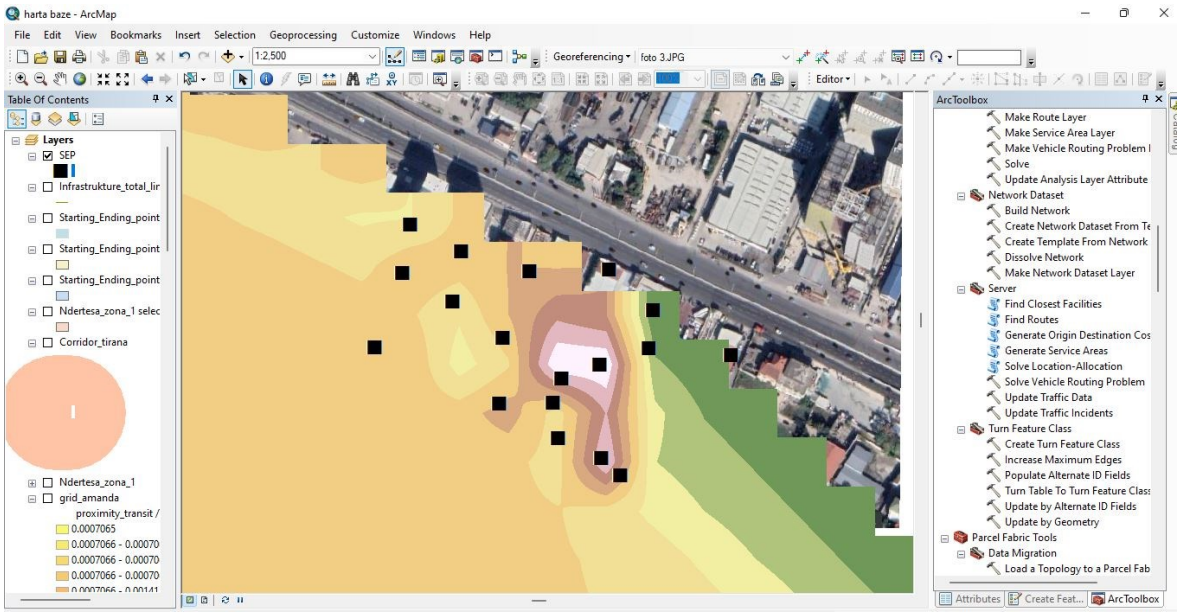


Figure 37 Model builder creating the Mixed-use parameter data aggregation

8.5 Measuring and investigating Walkability

Walkability is actually a very basic concept to understand. It basically defines in a simplified idea if I can go from (A) to (B). As investigated in this research the walkable distance simply defined as the 500-meter of possible walkable area. However, walkability is a much more complex structure that can be viewed as possibility of spatial access. This refers to access in adjacent properties. The synergic integration of the main components measuring walkability names walkability in a relationship between sustainability and environment. In our case the indicator is measured as follows. The walkability is measured considering walkable distance (the time you spend from the closest to the furthest limit of the area), attractor value (the number of services, infrastructure and intramodality), network measure and betweenness (the space left in-between).



The first generated value for the walkability in reference to the adjacent space. The map has a superposition of the main billings, their functions as defined in the second index and considers the two main infrastructure nodes of the area.

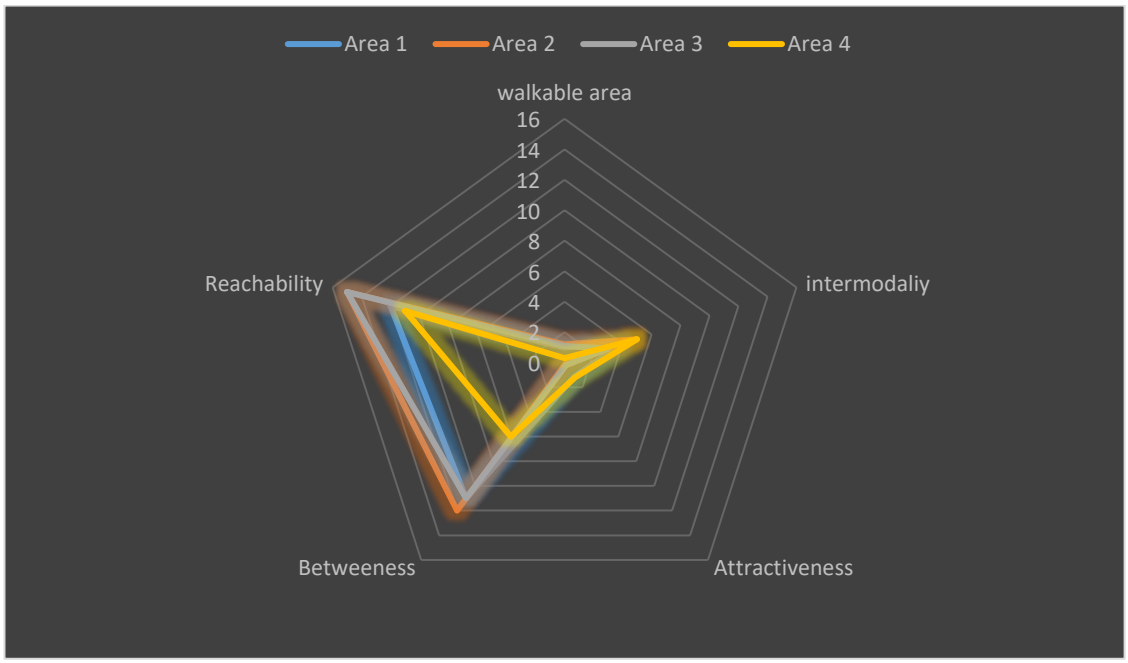


Figure 38 The data of the measure of Walkability considering the 5 components of measure

Integrating this data into a model would be the overlay of the five components of measuring walkability using the ArcMap and borrowing information from the first two parameters which were measured in the first part, the findings of this walkability show clearly that the “no use”, betweenness is very high in all of our case studies indicating that walkability is not fragmented but is limited by the permeability of the in-between areas. This indicator can help to improve urban condition since pointing out the areas of distress within the areas is notable. For the translation of this method, we have translated the parameters into a model for continuity through a model builder:

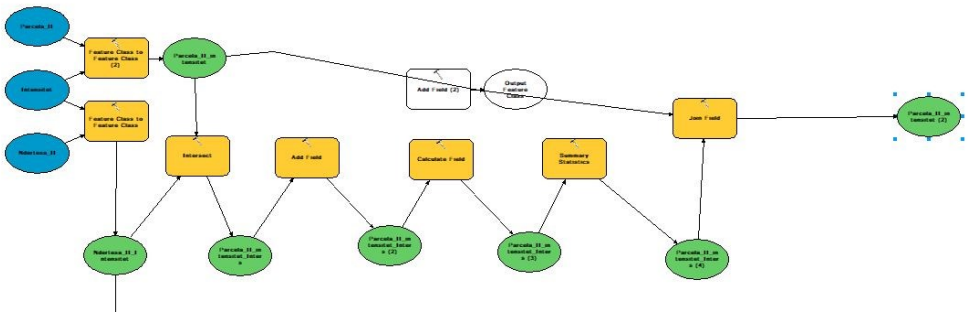


Figure 39 The model builder for the automatic calculation of the parameter of Walkability

8.6 Final data Aggregation

The importance of the data is only useful to professionals and planners, as a tool to measure a complete application of the TOD concept and its components. From our previous analyses we have identified the four main indicators with which we can measure the application of TOD. Our components have been treated as parts of a puzzle, as an attempt to create a relationship between these indicators and the urban condition.

As mentioned in the previous section of chapter 6, cities and the urban condition are quite complex and interconnected, influencing development. Therefore, the indicators have been broken down and each is analyzed through a specific, context

appropriate measure. Starting with Density our first indicator has been broken down into five individual components as shown below:

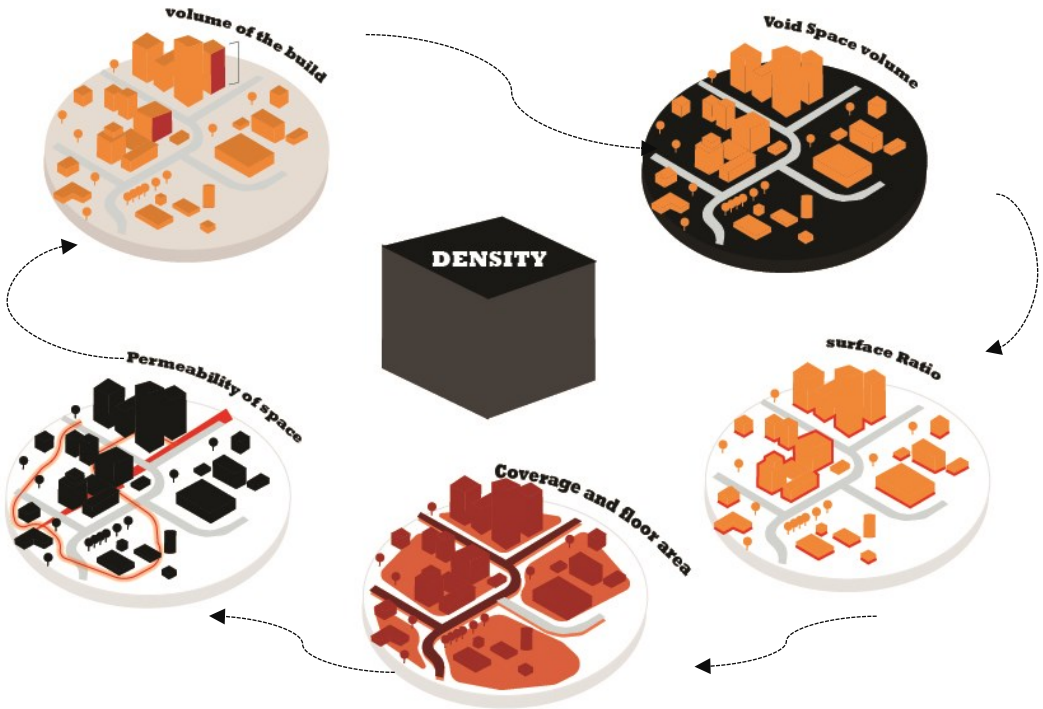


Figure 40 The Measurable indicators for the TOD component of Density Isometry created by the author

These five components were measured individually to create a separate environment for each of the indicators as a final product we were able to measure automatically by using the model we generated, the vertical and horizontal unconventional density of our three study areas.

Our second component is the measurement of Proximity to transit. By measuring this component, we provide a full and complete understanding on how the area is serviced by public transport, bicycle infrastructure and walkable distances, coming together with the total infrastructure network and the distance from each building to the nearest station as illustrated by the two components of this indicator:

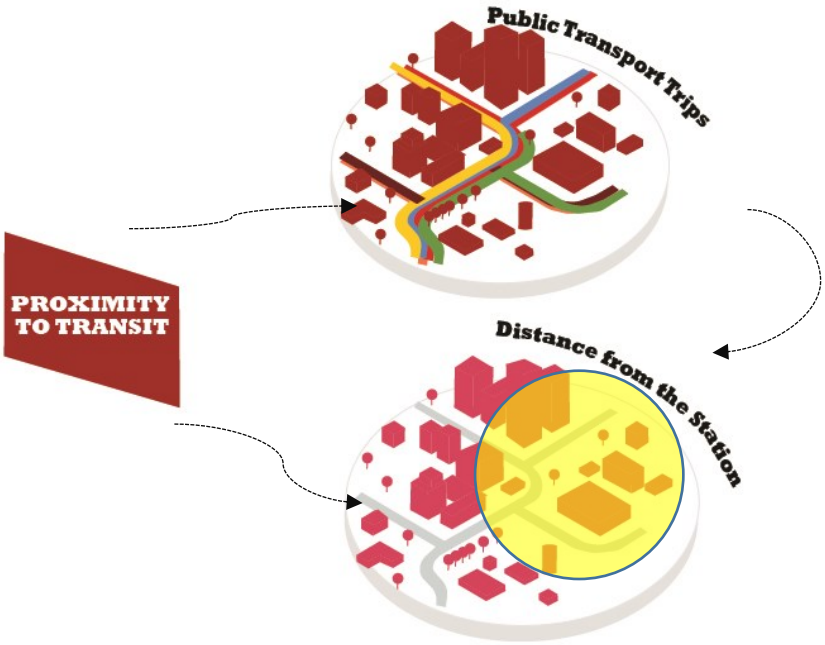


Figure 41 The Measurable indicators for the TOD component of Proximity to Transit / Isometry created by the author

The measurement of the components of this indicator must proceed the Density measurement, since the input for this data is the output of the total footprint of the buildings that we derive from the measure of the density in the first part of the indicator calculation.

Measuring mixed-use is a rather complex indicator which must consider a number of area characteristics. It is the third component which uses as input data from our second component the proximity to transit, taking these analyses a step further, considering three datasets as illustrated below:

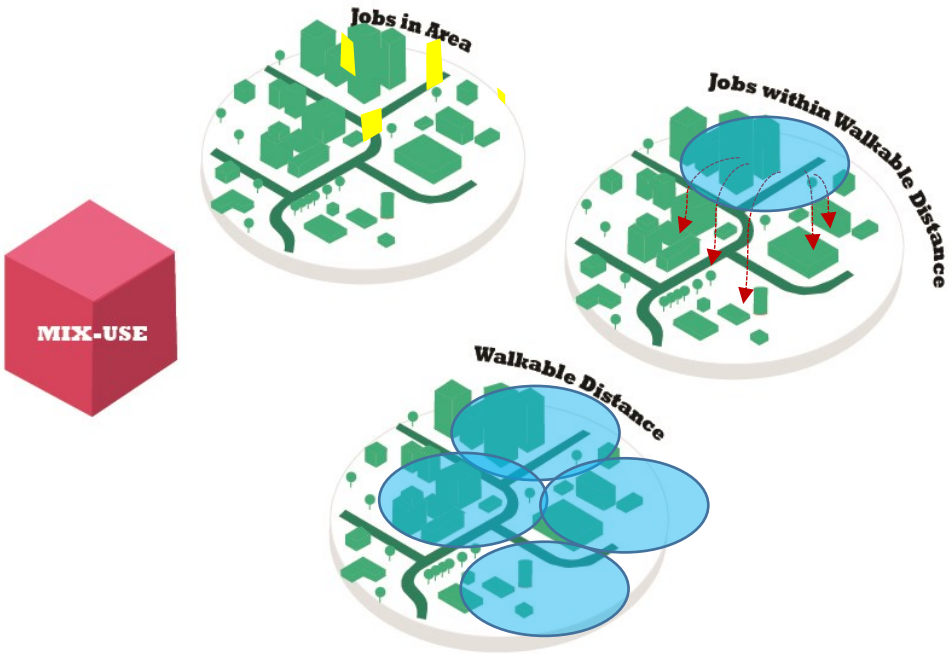


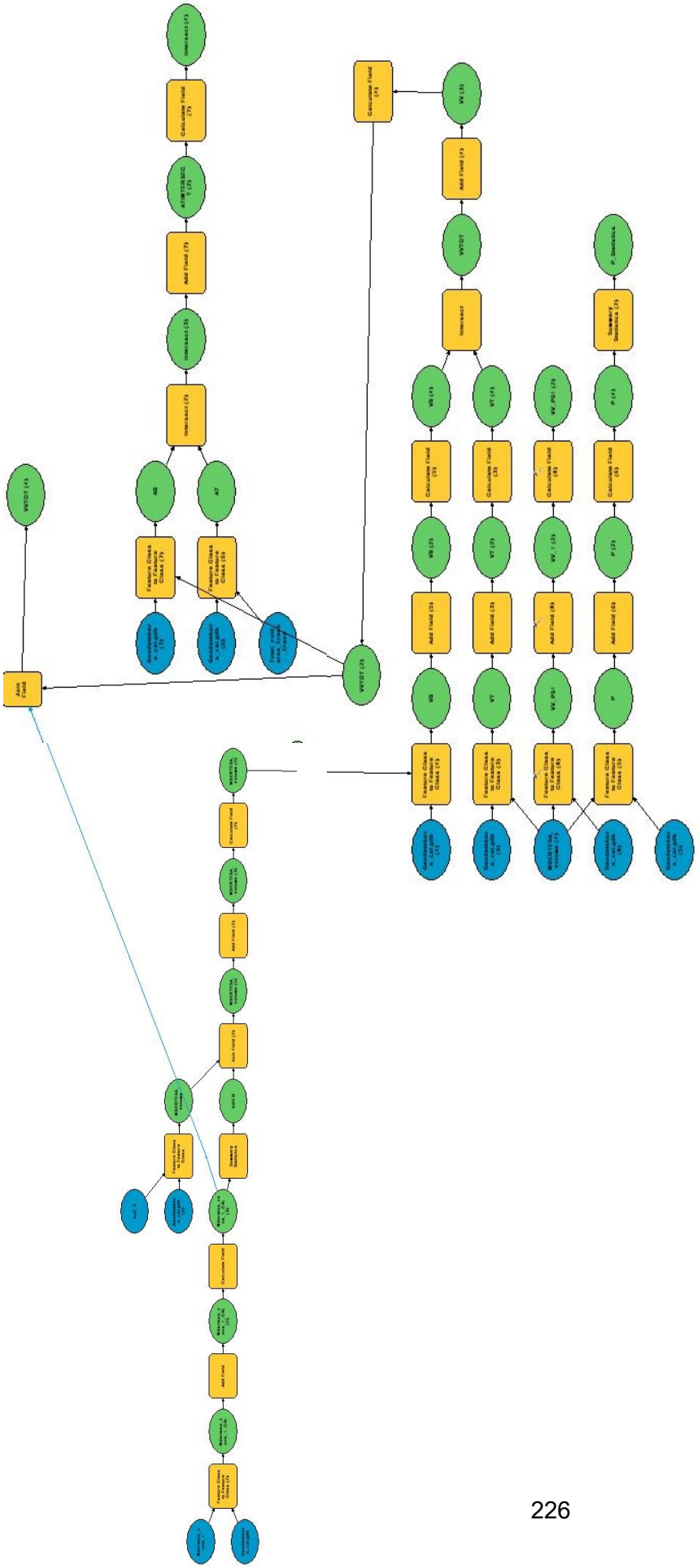
Figure 42 The Measurable indicators for the TOD component of Mixed use / Walkability / Isometry created by the author

The representation of the data we extracted from our indicators in the three study areas is constructed by each indicator output being the input for the next indicator calculations, creating a chain of interconnected data, representing the translation of the TOD principles in the area. The correlation between the data is established in the creation of the final model, translated into a universal tool for measuring "TOD" through its parameters, giving us the possibility to apply this tool in the future by only changing the input of the data, area, scale or even the characteristics. This final model is a tailor-made correlation between the data we extracted from our site, the indicators of each parameter and the limitations, represented by our choice of case studies from the three successful TOD applications we used in the case studies. The final model is nothing but an urban measure tool, that allows planners to make necessary evaluations, into the adaptation of TOD concepts at its fullest and parameter evaluated level. The model allows future prediction and scenario development, in relation to the input data. The case of Tirana outcomes established the necessary decision-making in order to establish the TOD in our three areas.

The first area shows low number of densities, high number in porosity (walkability/ open space) high access to transit stations and low number of mixed-uses within

the area borders. The second area has a high percentage of density within the area, low number of porosity (walkability/open space), very low access to transit station but high level of mixed uses, the third and final area has a low percentage of density (however, this area is still undergoing construction), high number of porosities, low access to transit stops and low number of mixed uses.

These findings help us understand that the areas have space to intervein if we decide to incorporate TOD into future development, in our last section we can compare these findings to our best-case studies of the four cities US/Europe to understand what we need to increase and how in order to improve the area in TOD-oriented way.



The final model as described above will be our main tool for comparing the "deficits" of TOD components application into an urban context, and case studies Findings on the components have some room for interpretation since the contexts of TOD are very different to the case studies, leaving some room for professionals and planners to define what components should be rearranged to increase

9 CHAPTER NINE | DISCUSSION OF FINDINGS

9.1 Conclusion

9.2 Theoretical conclusions

The first formal crises in urban planning occurred in the 1960s, during which the technical reasoning of blueprint design came under scrutiny from a number of sources, including the American Planning Association. City transportation is a guiding force, both in terms of presenting examples of futuristic plans for cities and in terms of the impact that cities have on the rest of the globe. Their personal and professional lives were influenced by the futuristic ideas that were all centered on or in close proximity to transportation, regardless of how controversial or unfeasible their atopies may appear today. They were encouraged to consider a new perspective or shift their conventional thinking. Frank Lloyd Wright works, such as Broadacre City (1932), La ciudad lineal (1882), and Michael Graves and Peter Eisenman's The Jersey Corridor (1965), show parallels with the examples above, as do other works by contemporary architects. Broadacre City, La ciudad lineal, and La ciudad lineal are some of the other works of Frank Lloyd Wright that are worth mentioning. Our above-mentioned utopias have similar viewpoints on the not-too-distant future, with a special emphasis on density, transportation-centered development, services in close proximity, and the general quality of urban life, among other things. When it comes to cities, "we think about transportation; the two

are intricately interwoven and have an influence on our relationship with cities," according to Purwanto and Darmawan (2014).

It has been a long time since the phenomenon of urban sprawl has been associated with negative connotations, and it represents possibly the most significant change in land use in European and North American cities. We may claim that this was a watershed moment in the history of contemporary town planning. Many theories have been developed to deal with both the prevention and after-effects of sprawl, as well as the effects of land use on the environment, with sprawl taking center stage and constituting a continuous issue. Ultimately, the function of transportation and mobility in urban environments is defined.
Consider the implications of systems theory and complexities inside our issue. We must return to the Habraken definition and comprehend the crucial element in the mix, which we may consider the significance of complexity in our discussion. Transportation, land use, urban design, and public spaces are all critical components of understanding and guiding complexity. Investigations have revealed that both urban complex systems, traffic flows, city networks, and the process of human mobility exhibit a scaling property, which is a property that increases in size as complexity increases. As a result, transit-oriented development takes into account the complexity of urban growth and transportation planning.

The philosophy of Transit-Oriented Development has undergone continuous development and refinement. The idea has grown as a result of its prior failures. There is no clear strategy on how to transfer the theory into practice in the future.
The findings bellow help understand from the analyses of the case studies what is the importance of each component of TOD and how it fits in the overall concept. Considering our case studies, the findings are defined into primary important components, secondary important components, third components and instruments or policies aiding the overall process.
In the case of Arlington deriving from our case studies changes in the area density and mixed uses into this density is very important the same characteristics are found in the case of Copenhagen and Vienna, the secondary important components are a mixture of proximity to transit stations and useable open space giving an

importance to complementary indicators, the third level components are mainly decision-making that effects the adaptation of the first and second component. Supporting the implementation of these components, each of our case studies has a strong tool for the implementation and overall inclusion of these urban components. The case of Arlington and Oregon is the drafting of a strategic plan, Copenhagen and Vienna relay on regional development plan as supporting strategy for the implementation of these components.

Definition	***Important components***	***Secondary components***	***Third components***	***Supporting/Policies/ Instruments***
Arlington /Virginia	High and mid density	Preserve and reinvest in neighborhood	Expending Travel options	Strategic Planning Instruments
	Around Transit	Enhance open space		Future Traffic trends
	Mixed uses	Pedestrian and Bicycle environment	catalyze private development	
Portland/Oregon	mixed-use buildings	corridors according to market readiness	Guide future investments	Strategic Plan
	existing conditions			Strategically Target Program
Copenhagen, Denmark	mixes residential and commercial	maximizing access to public transport	optimizing the use of land	Regional Planning
	hubs		secure long-term	new development corporation to manage and act as planning authority for future regeneration
Vienna/Austria	mixed-use development	building a completely new district	value capture	
			growth in public transport	Strategic Plan
	Car-restrictive measures	maximizing access to public transport	Increasing quality of life	

9.3 Definition Conclusions

Transportation-oriented development (TOD) projects are widely cited as effective methods for increasing transit use and lowering vehicle use while simultaneously spurring local development and improving the quality of life in otherwise deteriorating regions. Generally speaking, TOD is characterized as a style of urban development that brings together a variety of uses in a pedestrian-friendly, densely constructed area around a public transportation station (Litman, 2017). We ask whether TOD theory and practice are replicable by the creation of an automatize model since TOD is a complicated theory with many components the implementation of which includes various stakeholders and levels of government over an extended period of time

During the first part of our study, we focused on the theoretical implications of the theory, relaying on theoretical implication to understand the theory of TOD as firstly portered by Calthorpe, Bartolini, Cervero and my others, which traded the theory as important components of cities development giving their own definition according to the context. Some these definitions can illustrate from the table below.

Authors	Definition	Year
Peter Calthorpe	TOD was suggested as a compact, mixed-use community that was based around a transit station to encourage residents, employees, and shoppers to drive their cars less and to use mass transit more	1993
Salvensen	Development around a transit station providing opportunities for a diversity of land uses in a specified geographical area, development within a specified geographical area around a transit station with a variety of land uses and a multiplicity of landowners	1996

Boarnet and Crane	The practice of developing or intensifying residential land use near rail stations	1998
Still	Mixed land use development encouraging people to live around the transit services, at the same time decreasing dependence on a private vehicle	2002
Cervero, R / Ferrell, C / Murphy, S	A transit-oriented development (TOD) system is mainly designed to enhance the use of public transport/transit and to create an urban setting providing pedestrian-friendly environment.	2002
Tom Still, Zane Bishop, Hank Dittmar & Gloria Ohland, Carey Curtis, Peter Calthorpe	TOD promotes mixed use in buildings, high density and pedestrian- friendly development around transit to promote transit riding, increase walk and bicycle travel, and other alternatives to car use. Aims to promote development without adding to sprawl, freeing open space and adding public transportation".	2003
Transit Oriented Development Institute	Transit Oriented Development (TOD) is a new concept focusing on efficient modes of transportation other than the automobile.	2015
Transit Link network	TOD was defined as a combination of land use and transport planning that makes walking, cycling, and public transit use more convenient and attractive, while also optimizing the capacity of existing transit services by concentrating on transit hubs, and nodes	2012

Table 13 TOD Definitions treated into the chapter 4 Source: authors own elaboration

During this section a special focus was put into the theoretical connection between transportation, mobility and land use, were findings from (Banister D. , 2018), (Bernick M, 1997), (Bonavia, 1936), (Hayden, 2004) help establish the theoretical

bridge for answering the first question of this research. Quoting Banister, the connectivity between transport and land-use is undeniable, since the beginning of development one has influenced the other.

Our theoretical journey considered our case studies into chapter six which also allowed us to understand which are the important components of TOD and what are these components, the use our matrix help put in prospective the connection between first important components, secondary components and supporting measures. At the end of this section, we had already answered the second research question acknowledging our five main components for TOD and three more components added by (Jacobson, 2008) were we considered security, walkable and cycle orientation and scale of implementation as integral components as well.

Our theoretical journey shifted to an applied research journey, since we established the bases for this theory in chapters 2-4, learned by analytical literature review and SMCA the components of TOD, understood their importance. He crossed over to the Tirana case to firstly understand in a more western Balkan experience if and how TOD can be applied by measuring all the components in one single environment using the IMM methodology to define how measuring these complex components in a vertical and horizontal way should make space in a GIS model builder model. The model we have built does consider all of these components and gives way to measuring them in a single environment. This also answers our final question by creating this model we can replica these measurements in every scenario and context by changing the input of the case with those from the context in question.

9.4 Analyzes Conclusions

The data is only valuable to experts and planners since it serves as a tool to measure and evaluate the overall implementation of the TOD model and its constituent parts and components. Based on our prior research, we have identified the four primary indicators (defined in chapter 4.) Density, Mixed-use, Proximity to transit, walkability that may be used to assess the effectiveness of TOD implementation. Our components have been considered as if they were each a

piece of a puzzle, in an effort to establish a link between these indications and the urban environment.

As previously discussed in the preceding section of Chapter 6, cities and the urban situation are extremely complex and linked, and their growth is influenced by these factors. Therefore, the indicators have been split down and each of them has been assessed through the lens of an appropriate measure for the given situation. For example, the density indicator has been decomposed into five distinct components, as indicated in the table nr.14 below:

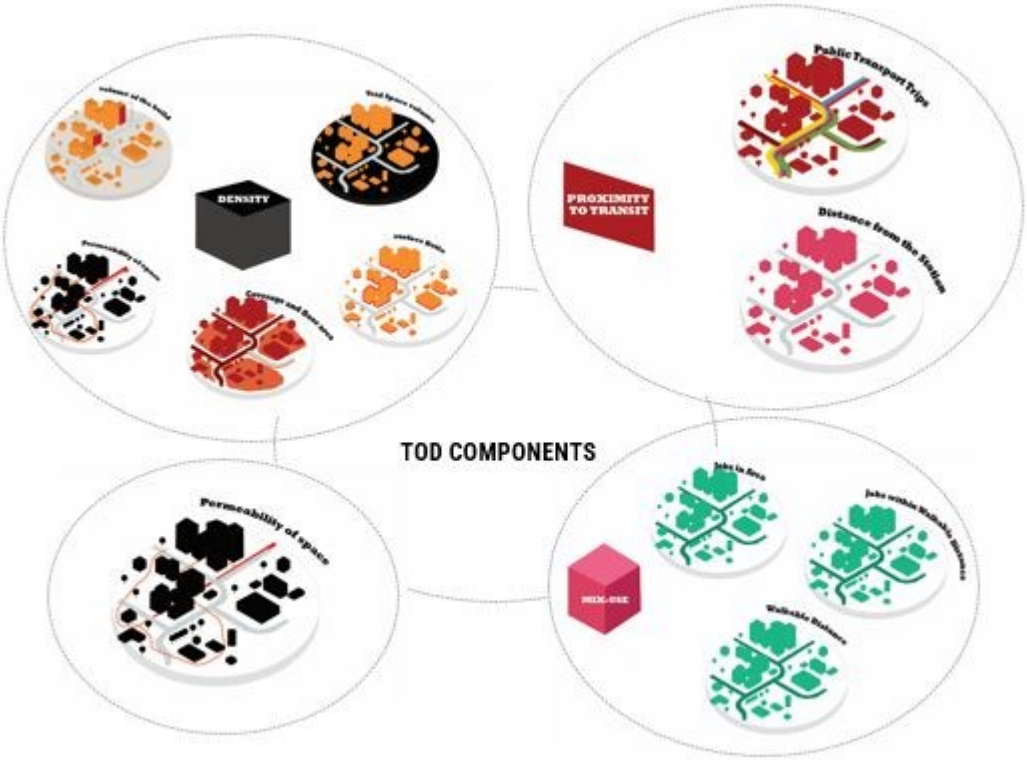


Table 14 Criteria of Components evaluation established by the theoretical review in chapter nr.4 Source Authors own elaboration

In order to build a different environment for each of the indicators as a final result, we were able to measure automatically by applying the model we built the vertical and horizontal unusual density of our three study regions using these five components independently.

By measuring the proximity to transit component, we can gain a full and complete understanding of how the area is serviced by public transportation, bicycle infrastructure, and walkable distances, all of which are combined with the total infrastructure network and the distance from each building to the nearest station, as illustrated by the two components of this indicator: distance from each building to the nearest station and distance from each building to the nearest station.
The representation of the data we extracted from our indicators in the three study areas is constructed by using the output of each indicator calculation as the input of the next indicator calculation, resulting in a chain of interconnected data that represents the translation of the TOD principles into practice in the region. The correlation between the data is formed during the development of the final model, which is then converted into a universal tool for measuring "TOD" through its parameters, allowing us to use this tool in the future by simply modifying the data input, area, size, or even qualities.

A custom connection between the data we acquired from our site, the indications of each parameter and the restrictions, which were represented by our selection of case studies from the three successful TOD applications we represented in the case studies, has resulted in this final model. Ultimately, the model is nothing more than an urban measurement instrument that enables planners to perform the essential assessments into the adaption of TOD principles at their most comprehensive and parameter analyzed level. With respect to the input data, the model is capable of making future predictions and developing scenarios. Our three regions were formed as TODs as a result of the outcomes of the Tirana case, which established the required decision-making for our TODs.

The comparison between the data is reflected into the matrix, which allows professionals to understand and evaluate these areas, and any new application in the future. As we have considered the urban challenges that cities face, in our first chapter, were concepts such as smart cities, 15 min cities and many more that were considered and broken down to their bare components. We highlighted the similarity of these components and the importance each of them has in implementing these models. One important outcome of this study is related directly

with the adaptability that the generated model holds. In the case of 15 min cities many of the components are quite the same, so in translation this model would easy be adapted, changed, and reused to measure how smart cities are developed in relation to their components, how 15 min cities should be translated to what level and how. This is what using Geographic Informational Models is aiming, and how easily planners and practitioners can “test” different contexts, add more components or simplify the models to measure each component individually.

In addition to case studies, the final model as described above will serve as our primary tool for comparing the "deficits" of TOD components application in an urban context. However, because the context of TOD is vastly different from the case studies, findings on components have some room for interpretation, allowing professionals and planners to determine which components should be rearranged to increase the TOD-ness of the area.

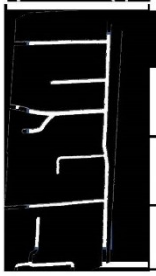
TOD COMPONENTS		PUBLIC TRANSPORT				Walkability	
	PROXIMITY TO TRANSIT			PROXIMITY TO TRANSIT			
			DENSITY			Security	
	MIXED USE						
Selected area	Working activities 400m	Travel accessibility	Density index	Proximity to CBD	walkability	FAR	Data derivation
Portland, Oregon							
	3.1	1.1	5	2.4	1	1.35	high density Low services
	4.2	2.2	6	2.5	2	1.6	high density higher service
	3.3	2	4	3	2.5	1.2	low density high service
	1.5	1.5	3	3.1	3	1.1	low density / high service
Arlington, Virginia							
	4.2	1.2	4	1.8	3	1.35	low density higher service
	2.1	2.2	3	1.4	1.7	1.52	high density
	3.6	3	2.5	1.2	2	1.2	low density higher service
	4.3	2.6	5	3.1	3	2.1	high density
Copenhagen, Danmark							
	1.6	0.7	7	2	1.1	1.4	high density Low services
	3	1.4	6	2.3	1.4	1	low density higher service
	3.2	1.9	8	2.5	3	1.4	high density higher service
	3.5	1.4	4	1.7	1.5	0.7	low density
Tirane, Albania							
	1.5	0.7	2.8	0.7	0.7	0.7	low density Low services
	3.2	1.1	3	2.3	1.1	1.4	high density Low services
	1.8	1	3.1	2.5	0.7	1.6	high density Low services

Table 15 Final Matrix of the best scenario case studies data comparison and Local case study of Tirana data comparison Source: Reserchers own elaboration

The final correlation of data represented in our findings table nr. 15 takes into consideration the data extracted from the US experience case studies and the European case studies, as successful applications of TOD components and compares these data to our Tirana case study.

As we have demonstrated in the analyses chapter nr four, that the measure of our density is viewed as a complex element considering all of the data findings measured by our case studies, such as working activities within a radius of 400 m,

the travel accessibility from point A (referring to the starting of the measure in this case each building block) to point B(referring to the nearest station), (within each area of 500 meter), the index of conventional density, the proximity to the Central Business District, the index of walkability in the area, and the FAR parameters. The measuring of the density for our case study considers an unconventional density which goes beyond these indicators, and this is something applicable in all our components. This was the main reason for the selection of our methodology (IMM), since this novel methodology, measures indicators such as density, proximity to transit, walkability, permeability and security in both horizontal and vertical ways. This means that the components measured in each of our areas have both considered as a minimal the conventional density adding a more comprehensive view such as future void build area, volume, nearest link and permeability. However, for the purpose of this study we have classified only the components that we have extracted from our case studies. In the measure of mixed uses in the area we have considered five elements, such as working activities within a radius of 400 m, the travel accessibility from point A to point B, the index of conventional density, the proximity to the Central Business District, the index of walkability within the area. In the measuring of proximity to transit, we have measured working activities within a radius of 400 m., the travel accessibility from point A to point B, the proximity to the Central Business District, and the index of walkability within the area. In measuring public transportation, we have considered the travel accessibility from point A to point B, the index of conventional density, the proximity to the Central Business District, the index of walkability within the area, and the FAR parameters. The purpose of these component was to bring a visualization to the model of TOD we have created. Comparing the parameter of each area with the successful TOD case studies to easily identify how to increase the TOD-ness in the area.

In the Tirana area from our comparison to the successful application of the TOD components, we can see that the density is low in comparison to European case studies, but not in comparison to the US case studies. The accessibility index is very low in all of our areas almost 1:3 of the case studies, walkability of the areas is very low, and it almost represents a deep problem, influencing the other criteria.

From these findings and measuring each component separately as we have demonstrated in our analyses section and then by understanding and comparing with the case studies, we can establish how to intervene in the area to increase the TOD-ness of the overall area. The three selected areas of the Tirana case share some characteristics with the Tod components, however as we can see in Table nr. 8 our areas have a combination of low services and low density (Area 1), demonstrating that this area has very low TOD indicators, and would require more intervention if TOD would be a possibility of development in the area. In our second area our (Area 2) in the high density but low services, the transport corridor had divided this area, but in contrast with our US/EU case studies the density is much higher that the US case studies, however the services, walkability and permeability within the area are quite low. To increase the TOD-ness of the area the criteria must consider increase services and open space to improve walkability within the area, and reach the European case study standards. Our third area (Area 3) as a new development had a high level of services with low density, low access to transit and low walkability, this area as a newly build space would require an increase in the future void/ build parameter in order to possibly increase the density and provide better walkability possibility within the area itself.

Finally, the creation of the Model is a step-by-step automated way of measuring the identified components of chapter nr.4 as a bundle. The possibility of measuring this parameter individually completely exists and would come as process itself, however the model-builder allows planners, architects, city officials and practitioners to operate in an automatic way in each context by changing the input of the area, based on the context. The final model is a reflection of each parameter into a single environment.

This is translated into a tool within the toolbox in order for the planner and urban analyst to use in order to measure the application of Tod in different context. The model allows us to understand the “best” application of the parameter into our case studies as a guidance of what improvements need to happen in the area. By using this model, the process is easily replicable to different context and areas.

The application of Tod though our method, does not mean that Tod can be or should be applied everywhere, after all this model of guiding development is what cities are aspiring to do. The model itself as a tool within the toolbox can be used by everyone, but need to be used by planners in order to interpret and translate the data to the best scenario including the context.

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Metamorphosis though Transition / The application of TOD as mobility / land-use model, and its applicability in the case of Tirana