الجمهورية الجزائرية الديمقراطية الشعبية
Algerian Democratic and popular Republic
وزارة التعليم العالي و البحث العلمي
Ministery of High Education and Research Science

Mohamed Kheider University of Biskra
Faculty of Sciences and Technology
Departement of Architecture

جامعة محمد خيضر بسكرة
كلية العلوم و التكنولوجيا
قسم: الهندسة المعمارية
المرجع:...............

Thesis presented to obtain a degree of:

Doctor of Science in Architecture

The impact of the spatial context on accessibility choices in Algeria - the case of the city of Constantine

Presented by: **FAREH Fouzia**

Supervised by: **Pr, Alkama Djamel**

Publicly defended on …………………

In front of a jury composed of:

Bouzaher Soumia	Professor	Chairman	Biskra University
Alkama Djamel	Professor	Rapportor	Guelma University
Madani Said	Professor	Examinator	Setif 1 University
Madhoui Myriame	MCA	Examinator	Biskra University

DEDICATION

I want to dedicate this work to my family, namely my Mother, my sister Fadila, my brother Salim, and my Father, and to all people who encouraged me to accomplish this thesis, especially Rahma Florence Chevalier and to all the good, human, and altruistic people who helped me to see clearly and to pick myself up whenever I lost my energy.

The important thing is not to arrive; the important thing is the path

AKNOWLEDGMENTS

I thank the Almighty God for all the blessings and this is one of them

I thank myself for everything

Special Thanks to my supervisor, Alkama Dajmel who believed in me.

LISTE OF FIGURES

LISTE OF TABLES

TABLE OF CONTENT

GENERAL INTRODUCTION

1. Introduction

Understanding the relationship between the spatial structure of human settlements and the social life of their inhabitants is one of the central challenges of city planning. Yet despite extensive investigation to date, the relationship between the spatial configuration of cities and the social processes that take place in them has proven to be a topic of great intricacy, with only little accessible developments to elucidate a dissertation on the subject.

Jane Jacobs has defined cities as issues of ordered complexity, which not only include a high number of variables but also provide an analyst with numerous interrelationships between the variables (Jacobs, 1961).Moreover, the current level of knowledge of the dialectics of the form process shows that general questions such as the impact of urban structure on social lifeare rejected at the outset, as more interactions are found out than any single answer could reasonably imply. More importantly, the concept of complexity implied by Jacobs' view of cities implies that any single interaction between form and use is unlikely to be unique or predictable. Moreover, the theory suggests, that, the connection between the user and its urban stricter can take many forms and depends on a variety of other conditions that may influence people's use of space other than spatial form.

Discovering the social life production process in urban spatial contexts is a necessary step in the evolution of modern urban planning and design. A collection of spatial relationships originating from the urban form and its underlying interaction between diverse urban entities is referred to as spatial structure. According to new urbanism precepts, the socio-spatial dialectic contends that social events are generated by space, constrained by space, and mediated by space. Many ancient cities include evidence of how civilization is geographically replicated, where social hierarchies match with the physical organization of human habitation to a great extent.

Modern technologies have extensively exploited human mobility in contemporary cultures, resulting in extraordinary urban expansion over the previous century and a half and (re)shaping the urban setting with multiple scattered, hierarchical, and interconnected centers (Buliung & Kanaroglou, 2006). As a result, the complexity of modern city systems has been given as a challenge for recovering the theoretical relevance of urban form in current social life procedures and for developing important methodological advancements. Throughout history, modern urban planning has been used as a main tool to alleviate the social evils of cities.This theory of spatial determinism, which closely links socioeconomic status to architectural elements, has been critiqued for its 'naive' spatial interventions, with simple geometries, and its failure to confront the ordered complexity of social, economic, and cultural life in the post-war age (Jacobs, 1961; Webber & Wurster, 1963) . This critique originates from practical reasons, considering the dismal outcomes of a number of large-scale urban redevelopment programs. The lack of successful reflections on these concerns by urban designers has exacerbated urban design's marginalization in mainstream contemporary conceptions of urban studies. Parallel to the'social turn' in modern planning history, which saw the emphasis shift from individualist invention of 'ideal' public spaces to collaborative planning of functional and democratic spaces (Healy, 1997), important theoretical developments in urban design emerged from the 1960s to the 1980s, which in turn contributed to the ‘spatial turn” in social sciences. The relevance of the built environment—the'second nature,' an artificial nature—in urban production and consumption processes has been highlighted in Neo-Marxist urban planning ideas (Lefebvre, 1974; Harvey, 2010). Likewise, significant attempts have been undertaken to examine the defined spatial logic of city attributes. For example, Kevin Lynch, (1964) offered a taxonomy of urban spatial features for producing visual quality across places. ChristopherAlexander, (1977) quantified the pattern qualities of urban form and their relationship to the vibrant nature of urban life. Hillier and Hanson, (1989)investigated the structural features of urban form, developing a configurational study of urban structure called space syntax, which focuses on the interaction of spatial elements, each of which is determined by its relationship to all others. Although these advances created the theoretical underpinnings for the social significance of urban form, the necessity to determine the function of urban form in social processes remains (Talen & Ellis, 2002). Scholars require theoretical and methodological advances, as well as empirical validation, to produce a deeper understanding of the dependency between contemporary spatial and social structures; such advances are required to bolster their arguments for any social good that could be brought in by urban design.

The general view of urban design within the larger field of city planning today has progressed to the point where it is no longer a question of whether there are additional influences on social behavior beyond spatial configuration. This dissertation is largely motivated by a conviction because: First, as a growing proportion of human activities take place in cities (United Nations 2007), it becomes increasingly important to understand how the physical environment of the city influences social behavior.The arrangement of the built environment — the physical pattern of urban infrastructure, the geometry of constructed form and its circulation patterns, the design of public space, and paths that connect them — constrains most everyday activities of city inhabitants to varying degrees. The underlying social value of urban shape thus arises from its universal usage. The tremendous development and evolution of cities necessitates attention to form and more empirical investigation, not disregard. The repercussions of ignoring spatial arrangement and geometry in modern city design might be as severe as their overemphasis on mid-century urban rejuvenation.

Second, despite the lack of expert understanding of the components of 'excellent city form,' a layperson's attraction to wonderful urban settings such as Paris, Porto, or Hong Kong attests to the crucial role that urban geometry plays in molding our attitudes about cities. Rather of relegating the feelings evoked by attractive urban surroundings to the domain of the metaphysical, we should try to analyze them methodologically. Learning from previous experiences is, of course, an important part of a designer's education, but attempts to recreate the beneficial attributes of prior precedents sometimes appear to result in copying and kitsch, rather than constructive knowledge for intelligent, context-appropriate design. To have a deeper knowledge of the social implications of environmental geometry, antecedents must be analyzed not just via blueprints, but also through observation, user accounts, and other types of social, economic, and environmental data.

Finally, significant advances in configurational studies have happened since Lynch and others' writings, opening up new avenues for empirical study on city design. Among these, the widespread availability of computers and data that characterize both static and dynamic components of the city have significantly increased an analyst's ability to investigate complicated linkages between architectural form and occupancy patterns. Geographic information systems (GIS), computer-aided design (CAD), digital databases, and statistical tools, which were virtually inaccessible to urban designers a decade ago, are now readily available. At the same time period, geographically referenced digital data defining the city's physical, social, and economic environments were available for research. These advances have opened up a number of new avenues for theoretical and empirical ideas regarding city shape, as well as sparked an active field of urban design study. The physical component of the urban environment is the 'built environment,' which is inextricably linked to the social environment. Constructed environments encompass anything that has been built, changed, organized, or maintained by humans. Hence, the built environment refers to the products and processes of human production as a whole. It predates humanity. Yet, the term "built environment" is a very new and broad idea. We have studied and analyzed the built environment under several headings such as architecture, urban design, urban planning, and so on.Considering the "constructed environment" as an all-encompassing concept makes a significant difference since the emphasis is now on the interrelationships between its components as well as the interrelationships between man and environment. As a result, the built environment as a paradigm is significant for studying user preferences.

Constructed environments are a fundamental structure of space since they are made up of space (un-built) and matter (built). The spaces are linked to one other, establishing a "system of spaces". The spatial layout of the built environment is determined by how these discrete areas are produced and, more significantly, connected together. The evolution of spatial layout in a constructed environment through time is driven by socio-cultural factors such as user preferences. Hence, the constructed environment and the social environment are two sides of the same coin and that is the "system of spaces". They are inextricably linked, and one influences the other. It is a cyclical process in which changing the quality of spatial arrangements causes changes in social life and vice versa. Planners are in charge of constructing the built environment, thus they must comprehend human characteristics such as user preferences in a specific sociocultural setting. Some sporadic efforts by designers and planners have been mostly unsuccessful in attempting to emulate and transplant some of the qualities of traditional built environments to contemporary emerging built environments with reference to obvious aspects such as irregular geometry, without understanding the inbuilt logic.

In the Algerian context, one finds that there is a lack of systematic studies to investigate the built environments with respect to the spatial configuration and user preferences about space proxemics. Whenever investigations are conducted, they mostly focus on individual "places" with their size, shape, and enclosure quality using descriptive analysis. Knowing a city via its sections, or localities, has its own set of constraints. Cities do not create locations, but places create cities(B. Hillier, 2007). As a result, understanding the spatial organization of constructed environments as a continuous "system of spaces" is required.

The ways to dealing with the built environment are founded on normative planning practices and contemporary urban philosophies. Although traditional architecture has been extensively examined and documented, the traditional Algerian urban fabric, with its diverse range of communities, has yet to be thoroughly explored. Positive ideas that can help us comprehend the link between the user and the built environment are needed. Traditional Algerian communities' constructed environments, which have evolved gradually, show spatial arrangements that have encoded fundamental patterns of user preferences. It is unquestionably important to decipher this information by studying geographical patterns and using appropriate empirical investigations.

2. Statement of the problem

Cities, being complex systems, are composed of (at least) two subsystems: a physical subsystem composed of buildings connected by streets, highways, and infrastructure, and a human subsystem composed of mobility, interaction, and activity. Cities may thus be viewed as socio-technical systems. Any credible theory of urban complexity would have to connect the social and physical subsystems. Traditionally, most urban models attempted to make the link by defining the physical sub-system as a collection of distinct zones and distance in the physical system as a cost in the social system. Such models have been useful tools, but have contributed little to the creation of a more comprehensive theory of cities through time. Hillier's new theory of urban morphology suggests a more sophisticated and realistic model based on the concept of the city's physical subsystem as a network of spaces-streets and roads-connecting buildings, rather than as a system of discrete zones. This allows us to look at urban complexity in a new light.

The street network, according to this notion, serves as a spatial armature for the socioeconomic life of cities. The emphasis here is primarily on space rather than form. It is about the spaces defined by the boundaries formed by physical items placed in space. As a result, the street network may be viewed as the primary motor of urban life. As a result, street networks form the backbone of cities and correspond with urban growth. Different cities in the actual world have varied street layouts due to a variety of historical factors, physical surrounds, socio-cultural contexts, economic situations, and other factors. In this manner, analyzing street patterns may disclose many underlying elements of a city, making it critical for city planners and policymakers.

From many viewpoints, great attention has been dedicated to urban street networks. Planarity of transportation networks was established and measured by quantitative geographers and transport specialists in the 1960s. After that, a slew of global metrics of heterogeneity, connectedness, accessibility, and interconnectivity were suggested in order to investigate the topological structure of spatial systems. Space syntax, on the other hand, analyzes spatial configurations based on the spatial and social relationships in urban street systems; as a result, it gives a useful technique to sketch street networks and urban morphology from a topological standpoint. Nonetheless, given the importance of street networks in molding people's everyday lives, academics are especially interested in traffic flows and travel patterns of individuals.

Streets, pathways, and transit lines are examples of spatial networks that organize the human dynamics of complex metropolitan systems. They influence travel behavior, site choices, and the texture of urban fabric. Measuring these network patterns can assist researchers, planners, and community members in understanding local histories of urban design, transportation planning, and morphology; evaluating existing transportation system patterns and configurations; and investigating new infrastructure proposals and alternatives. It also advances city science by improving understanding of urban patterns and how they relate to evolutionary dynamics, planning, and design.

A recent topic in architecture and urban planning is the role of street networks as a spatial armature for city socioeconomic life. Being a dominant component of a city's spatial shape, they have been shown to have an influence on human spatial behavior, such as transportation, mobility, and accessibility, as well as the safety and vitality of urban life.

Pedestrian mobility, also known as walkability, is an intrinsic activity in the urban network that has been well acknowledged for its contribution to environmental quality and public health. Furthermore, it has been demonstrated that high levels of walkability add to the vitality and quality of the urban space.

Substantial study has been performed to learn more about how different features of the built environment impact pedestrian mobility. Such research has focused on determining how street design types, land use mix, residential density, and block widths influence the quantity and kind of walking trips. Additional elements influencing pedestrian mobility include the visual quality of walking infrastructure, perceptions of safety (from traffic) and security (from crime), as well as social, cultural, and environmental characteristics. The volume of pedestrian movement must be evaluated in order to create walkable and safe urban settings and to forecast transportation demand in both current and prospective contexts. Yet, collecting pedestrian statistics on all or even a portion of a city's streets is impractical. Pedestrian volume models are required to overcome this restriction. Pedestrian volume modeling is a relatively recent concept in pedestrian movement research, as well as a component of transportation demand modeling investigations. It focuses on understanding and assessing the geographical distribution of pedestrian movement within an urban roadway network. Following classic transportation models, some pedestrian volume models incorporate the relative attractiveness of land uses, residential and employment density, and availability to public transportation as explanatory factors.Models that rely on an examination of the urban street network itself, on the other hand, have recently come to dominate. The subsequent models were built primarily within the conceptual and methodological framework of space syntax and are based on the assertion established in many such studies that the structure of the street network impacts the distribution of movement within it to a great extent.

The spatial fluctuations of pedestrian volume in the street network may be described and predicted by the integration level of axial lines or mean depth of axial line segments between junctions of the axial map, according to pedestrian volume models built using the space syntax framework. These models showed a substantial association with mobility.

As a result, pedestrian modeling provides considerable evaluation of the geographic distribution of pedestrian volume based on the integration or centrality qualities of the spatial structure of the street network. Nevertheless, as stated in the previous research, pedestrian volume models built for different cities differ in the dominating centrality measures of the street network's spatial structure as well as other explanatory factors of pedestrian movement.

Furthermore, there is some evidence that these disparities are connected, at least in part, to the planning strategy employed to set out the investigated metropolitan regions, as well as the resulting street layouts and land use distribution. However, because most previous pedestrian volume models were built for historic urban areas that grew incrementally, without central planning, or areas that developed through traditional pre-modern planning, we know very little about how modern urban areas differ in the interaction between the structural properties of the street network and pedestrian volume distribution.

Algeria is a good place to look into the impacts of current city planning concepts on mobility patterns and land use distribution. The majority of its towns were constructed during the colonial period, although those created prior to the French colonization were planned and platted utilizing pre-modern nonhierarchical street-based design. Observation of the post-independence period reveals the influence of the modern planning trend, which results in the production of new towns to cope with rapid population growth. These resulting settlements are experiencing modern planning doctrines combining the functional hierarchy of streets with the neighborhood unit concept, resulting in dendritic and disconnected urban networks.

In this thesis, we use space syntax analysis to investigate how street networks' structural properties interact with pedestrian volume distribution in these two urban types (the traditional and the new neighborhoods). Understanding the differences between grid types in this respect might assist in the progress toward the construction of a generic pedestrian volume model for each urban area type. Such a generic model is needed to assist in the implementation of pedestrian preference on city streets as a part of improving pedestrian walkability regarding its most important role in sustainable urban development and sustainable mobility. Such a model is also needed to improve pedestrian safety, by localizing points of higher risk to pedestrians. Assessing the volume of pedestrian movements in existing and planned contexts is essential for planning safe and walkable urban environments and for forecasting transport demand. In the following section, we will describe the methodology used for constructing pedestrian volume models in the selected cities, namely; Ali Mendjeli as a town developed by the modern functional planning approaches, and the traditional town (La medina Alaatika) with self-organized planning. The results of the measurements and models led us to a detailed analysis of the relationship between the structural properties of street networks and the distribution of pedestrians within them.

3. Research questions

Question one:

How do traditional and modern urban characters affect pedestrian volume movement in terms of the street network configuration, and how do the self-organized and the planned layouts respond to that correlation if exists?

Question two:

How does the observed movement interact with the different network structural properties related to each study area, which means to what extent the nature and the scale of the centrality measure can predict the amount of pedestrians according to the type of neighborhood?

By seeking the answers to these research questions, the expected findings of this thesis could be of great value for urban designers or planners, and decision-makers in deploying an effective methodological framework to measure the spatial network and pedestrian mobility with the same theoretical propositions. In the following, we have some direct objectives to be realized by the end of this research.

4. Research hypotheses

Hypothesis one: We hypothesize that traditional urban neighborhoods, with a well-connected street structure, are likely to have not only more walking within it but also a more predictable spatial distribution of pedestrian volume than modern neighborhoods, which are characterized by hierarchical tree-like street layout associated with the idea of the neighborhood unit.

Hypothesis two: We hypothesize that the distribution of pedestrian volume in these neighborhood types interacts differentially with the street network centrality, the different types of configuration attributes tend to be much more varied in their correlation with pedestrian volume across scale.

5. Research objectives

The objectives of this study are:

1-Assess the impact of the spatial configuration on pedestrian movement distribution in two historically and spatially contrasting urban areas.

2-Explore which spatial-configurational attributes are more appropriate for predicting movement. more specifically, in which conditions topological representations (nature and scale) capture the actual pedestrian movement in each of the investigated environments.

3-Help produce desirable long-term networked properties, going beyond zoning regulations, aiming to produce desirable patterns of movement with more integrated neighborhoods.

4- The aim of this work is to assess the conditions provided to pedestrians in two cities with different urban morphologies: these findings could be fundamental for obtaining a broader and well-connected network of pedestrian streets. Therefore, this study has the potential to support urban planning decisions aiming at improving walkability and sustainability in cities.

5- This research builds on the premise that structural aspects of the physical configuration need to be considered as offering a significant, even over-riding, influence on walking behavior, reducing automobile dependence and inducing non-auto commuting.

6. Aims of the study

This thesis focuses on the configurational aspects of the urban street network process and its relation with pedestrian movement in two different layout cities. the aims of this study are:

-The primary aim of the research is to develop a model for measuring pedestrian movement, a method capable of enriching and improving the existing spatial network centrality measures with consideration of the spatial network's configuration dimension, this thesis looks to make more productive the tools in the relevant research, urban design, and planning practices, helping to address the current challenges faced in contemporary urbanization. Thus, such a method aims to relate pedestrian movement to urban form (the spatial configuration) and other aspects of urban performance.

-The second critical aim of this research, therefore, is to explore the extent to which the urban configuration interacts at various scales and simultaneously influence pedestrian movement. The 'configuration' here is defined as the spatial relationships of connectivity as the result of the geometric layout of the spatial elements.

-The third one is Uncovering the typologies of movements related to grid patterns, the topological structures showcase how urban grids can be distinguished into the pedestrian model, which further illustrates the dominant leading variable that triggers the movement into a given urban area.

-The research aims to revive the focus on street structure patterns in configurational studies to reclaim their significance in the estimation of people flows, in parallel with urban functions which are the origins and the destinations for travel behaviors.

- We aim to elaborate on the discussion of prior studies by testing how various characteristics of street patterns change walking activities in Constantine, Algeria. Furthermore, we attempt to assess the effects of the links and surrounding network features on street configurations. In order to better understand the impacts of the new metrics of street network layouts on walking volume.

7. Structure of the thesis

This thesis contains seven chapters:

Chapter One: Pedestrian movement and diverse implications of walking

Gives an outline of research into pedestrian dynamics and put the thesis in context. The chapter discusses why walking is important and outlines that there is a need for a greater understanding of pedestrian movement. It also suggests some reasons for the sporadic interest in the subject over the last seventy years and the recent revival and acceleration of interest in pedestrian movement from a wide range of research perspectives. The second half presents a review of behavioral knowledge applicable to pedestrian movement in the urban context under normal and high-density conditions. From research by psychologists, sociologists, mathematicians, and disaster planners. The role of behavior in the modeling and calibration process of data.

Chapter Two: Street network development and morphology

This chapter introduces the theoretical background of street networks, their structural complexity, form, and how they are shaped by planning periods and design ideas. In this work, we focus on the way in which how road networks have been instrumentalized to provide favorable conditions for individuals. the term traffic includes walking and biking, Public transport traffic is not addressed because it has particular issues. In this chapter, we will offer an overview of the variety of urban planning recommendations for the design of street networks. These recommendations have been divided into three paradigms which we believe have guided the process, from antiquity to the end of the twentieth century, when street networks were designed according to three paradigms: the street network as the image of the city, the street network as a place to live, and the street network as a traffic carrier.

Chapter Three: Built environment design and travel behavior

The goal of this chapter is to provide a conceptual framework for the relationships between urban design and behavior that may also serve as the foundation for empirical research. A single field or theory cannot describe the complex reality encapsulated in the concerns about the relevance of urban design for travel behavior.In this chapter, also, there is a focus on the study of urban morphology at various times and from varied viewpoints resulting in a broad variety of methodological outputs, which may be observed in numerous schools of thought. Furthermore, this chapter also outlines the contribution, the urban environment adds to travel behavior based on based on economic theory, configurational theory, social psychology, and environmental psychology.

Chapter four: Space syntax theory and method

This chapter has reviewed common methods for the representation of urban morphology and space syntax, which is most commonly applied in network analysis at different scales. One of the main reasons why space syntax is to establish a cross-scale reading between analyzing the part, the whole, and the relations therein, with the aim of scientifically tying abstract spatial relationships and specific block traits and characteristics. moreover, the complex and open-ended objective of this study pushed us to seek analytical instruments that go beyond the traditional trades and explore multi-fold readings in the endeavor to link between scales, urban grids, network extensions, agglomerations, etc. hence reading the urban environment in a continuous manner, unaffected by the spatial divisions and intrinsic socio-economic differences. The goal of this chapter is to offer a comprehensive description of the conceptual framework as well as the methodological and theoretical foundations for investigating the built environment using spatial-syntactical analysis.

Chapter five: Data collection tool

This chapter describes field observations on pedestrian movement and static activities in an urban environment. Field visits are often organized prior to planning and performing observations to gain a basic understanding of the site conditions and surroundings, designating essential functionality or land uses in the layout and making first judgments on where to assign observation areas. Consistent and well-structured on-site observations are often meant to quantify real movement and occupational behavior and verify spatial expectations in order to develop a quantitative description of movement behavior in the public sphere.

Chapter Six: case study

In this chapter, we present an overview of the new cities as an illustration of the paradoxes of urban planning and public policies in Algeria. This is the result of the voluntarism of local public authorities. We will focus our study on Ali Mendjeli, the new city of Constantine in eastern Algeria. Ali Mendjeli integrates a narrow and sectoral vision of the new city, responding only to a quantitative need of the various actors. A broad comparison between the new city and the old city of Constantine, our second case study, is also undertaken to quantify the apparent difference between them. These characteristics are crucial to understand since the age of some old cities is related to their ability to survive periods of transition and adapt to diverse environments. In summary, the study focused on the urban structure of old and new cities, including spatial organization, land use distribution, centrality, and mobility patterns, which characterize all physical, social, economic, and environmental aspects of a city.

Chapter Seven: The empirical research

This chapter begins by developing a methodological framework for this thesis. It begins with an introduction of the framework and the pedestrian volume model that is adopted for the whole thesis. A summary of all the methods that will be applied to the analytical chapters and an introduction to the case study as well as the related data and method structure extensively described. The second part of this chapter introduces the graph representation of spatial configuration and related syntactic techniques in the space syntax theory. Two centrality measures in the spatial network segmental analysis, including the angular integration and choice, and other measures are introduced. The next step is to present the spatial analysis of the case studies' street network according to the space syntax theory. the configurational analysis is done in a topological and angular method allowing us to identify explicitly the configurational variables. Then an empirical study of the relationship between multi-scale spatial measures and pedestrian volume was undertaken through a verification of the impact of the dependent variable (movement) and the predictors' variables (the different syntactic measures). The last step is the validation of the model, which is undertaken through other configurational measures independent of our case study.

8. Research Methodology

The investigation focused on the relationship between the spatial-configurational and functional attributes of the built environment and the volume of pedestrian movement in two spatially and historically different urban areas of Constantine city, considering the old and the new town.

In order to consider variability in the distribution of pedestrian volumes and non-residential land uses along streets, analysis of the data and computation of the centrality measures were based on the high-resolution spatial division of segments. Data on the case study cities' street networks were obtained from urban administration documents. Data on non-residential buildings were obtained from the field survey and georeferenced in GIS. The pedestrian data were collected by means of a count survey representing a range of different centrality values. Hence, the selected segments comprised approximately 6–8% of the total segments in each area. The metric distance at different radii; it has been found appropriate for modeling pedestrian movement. The analysis was based on Integration and Choice segment-based centrality measures for topological, and angular distance at different metric radii and at the city level. A segment map of each city's street network was created and analyzed by computing the space syntax measures using Depth map software version 10. In pedestrian volume modeling. The various centrality measures, are employed with observed pedestrian volume to be analyzed in Statview (ver. 5) software and presented using ArcGIS (ver. 10.3).

9. Scope of the Study

Configurational studies have produced powerful methods of measuring the structural properties of the spatial fabric. with the aim of augmenting the current theoretical and practical development of measuring the spatial structures of cities, this thesis investigates whether developing a pedestrian model of centrality measures can improve the predictability of various types of urban performance from an urban design perspective. To achieve this goal, a comprehensive method of measuring the geometrical centralities of spatio-functional settings, specifically within the well-established framework of configurational analysis. The findings of this research are expected to confirm the necessity of quantifying the movement behavior in conventional built-form studies for addressing the complexity of contemporary cities.

As it stands now, Neither classical morphological studies of urban layouts using a metric geometry framework, nor more recent studies of urban layouts using a fractal geometry framework have been able to effectively explain urban layouts at macro and micro scales. Nor have they consistently described the consequences of metric and fractal elements of design on human behavior. Given all of this, methodologies and measures of "space syntax" based on topological and topo-metric correlations between a set of well-defined components of urban layouts have been extraordinarily successful. This gap has been filled thanks to the efforts of scholars in the space syntax community. In space syntactic studies, it is maintained that urban streets are not only the elementary elements of configurational centralities, but also the fundamental units for social analysis. By viewing spatial networks as disaggregated data, space syntax research has shown that there is a dependency between them and their social relevance.

Motivated by previous attempts, this dissertation tries to forecast dependent movement patterns using the configurational centralities of the spatial network as crucial independent factors. One notable feature of configurational research, particularly the space syntax model, is the fine resolution that it provides for analysis. The use of roadway segments as units allows for geographically scalable outcomes, avoiding the so-called modifiable areal unit issue (MAUP) (Openshaw and Openshaw 1984).

On that note, this study does not attempt to use aggregated spatial data, such as census data, which lacks information about demographic differentiation across spaces within census units; rather, it employs location-based data about land use with geocoded coordinates that can be accurately assigned to street segments. By deleting the MAUPs, the robustness of the analyses and results may be ensured at a disaggregated level. To leverage the configurational logic of movement behavior, this study employs a variety of quantitative tools, including regression models and GIS-based visualization and analysis.These techniques can yield successful results that are similar to other models that use various variables, bringing together well-established knowledge in social science theory, spatial economy, and configurational research. These methodologies' optimistic outcomes make them feasible options for cross-validating the thesis's central point.

Constantine, a typical modern city in the process of rapid urban growth, is selected as the study area due to its values regarding the complexity of its spatial-functional contexts and the availability of data resources. It is argued that the analytical methods and the generated results in the case of Constantine can serve as valuable references for the new cities and the traditional ones which both belong to the same spatial context and creating an urban dynamic without one excluding the other.

THEORITICAL FRAMEWORK

CHAPTER ONE

WALKING AND BUILT ENVIRONMENT LITERATURE REVIEW

1. Introduction

Walking is one of the major activities of human beings. Its importance extends the simple goal of moving from one point to another; it brings pleasure and well-being. The planning and design of the walkable environment receive growing attention for its numerous benefits related to public health, sustainability, economy, and social life. For instance, to improve the health benefits of walking which are supported by scientific evidence, the design of an appropriate built environment may help people reach their physical activity goals in addition to individually oriented behavior-change interventions, by promoting and encouraging sustainable and healthy lifestyle choices. Therefore, there is an increasing need for knowledge about walkability in the built environment. While urban planning, urban design, and transportation research have also examined walking in urban environments (Gehl, 2013; Hillier, 2007; Maria Kockelman, 1997)what is usually referred to as "walkability" is a multidisciplinary field of research which has been initiated from the preventive medicine adopting the health beneficial aspect of walking as the most primary motivation (Saelens et al., 2003). Through the statistical analysis, walkability studies have shown that walking behavior is connected to both the state of the built environment and the potential health advantages it may offer. The goal of walkability research is to find environmental elements that influence walking, most frequently through analyzing correlations between various built environment characteristics and the amount of time people spend walking.

Although it is important to recognize the usefulness of the current walkability research as a framework that may significantly advance the study and practice of urban planning, it also has certain limitations in terms of practicality. This is due to two factors: first, a set of design criteria that are too vague to support, or might support practically any solution; and second, a method of analyzing urban form that lacks specificity, necessitating the need for certain results to be re-examined. The quantitative research that attempts to demonstrate a relationship between characteristics of the built environment and either the amount of people walking or the amount of pedestrian movement on specific segments struggles to produce results that are consistent and frequently lack applicability in the design and planning process. There is also the issue that the design elements that are frequently cited in urban design theories and discourses as encouraging walking or as creating a "pedestrian-friendly environment" are generally based on limited evidence, and some of these elements have been shown to be insignificant in quantitative analyses on the amount of walking. A deeper understanding of the connection between the built environment and walking is essential in order to learn how to address the disparities, restrictions, and inconsistencies that exist in the ideas and studies on walking.

in this chapter, we will try to build an extensive theoretical view and a deeper understanding of how the built environment impacts walking and also the complexity that exists in both o entities; the urban form and walking activity. we will try to understand the concept of walkability by trying to investigate the different ways/aspects the built environment affects walking, e.g. the built environment may directly influence the amount of walking by providing destinations, or enhancing the experiential quality of walking by identifying the condition as a walking (route) environment. Additionally, it explores the various aspects of walking by categorizing walking activities in terms of how they are influenced by different features of the built environment. By differentiating both the influence of the built environment (on walking) and walking activities, the knowledge that this chapter tries to produce is not only whether or not, but how and in which manner the built environment influences walking behavior.

2. Walkability Research a new emerging field

2.1 The role of walking in promoting public health

While walking in urban environments has been studied in urban planning , urban design and transportation research (Maria Kockelman, 1997;Hillier, 2007), a more structured body of work focusing on the "walkability" of the built environment has only lately emerged. This multidisciplinary study area on walkability, which is one that is expanding, was originally launched by preventive medicine (Saelens et al., 2003;). One of the reasons walkability research was started in the medical area was the alarming rise of obesity (Saelens et al., 2003). Obesity is becoming a serious worldwide epidemic issue, according to the World Health Organization (WHO), affecting people in both developed and developing countries. Lack of activity leads to between 200,000 and 300,000 premature deaths annually in the US (Mokdad et al., 2004).

In order to reduce obesity and promote physical health, 'walkability' research has focused on how the built environment can help achieve these physical activity goals. The reason this field studies walking, is that physical activity improves long-term health as walking is the most common form of physical activity among adults. Therefore , public health officials and policy makers recommend moderate-intensity physical activity, including walking and cycling, on most days of the week (Saelens et al., 2003).

Nevertheless, despite the advantages of regular exercise, it is estimated that more than 60% of the world's population is not sufficiently active to obtain the health benefits (Bell et al., 2002). Environmental, social, intrapersonal, and policy factors are only a few of the many variables that have been emphasized by the walkability models. Ecological hypotheses suggest that the combination of psychosocial and environmental policy variables will best explain physical activity (Saelens et al., 2003). Although psychosocial variables correlate with physical activity, they explain much less the variance in the moderate intensity of the physical activity, compared to vigorous physical activity. Walking and cycling are examples of moderately physical activities that can be done for a variety of reasons, unlike most vigorous physical activities that are done for health-related or recreational reasons. This makes these activities more susceptible to environmental influences. Urban form may have a lasting impact on a large number of individuals, unlike other elements that affect walking behavior such as sociodemographic traits, lifestyles, and attitudes, which vary for each individual. Based on these concepts, walkability research—which is still in its infancy—looks at how the built environment affects walking patterns.

2.2 Insights from earlier studies on urban planning and transportation

The greatest evidence that environmental variables might lead to low levels of daily physical activity was thought to come from transportation studies (Saelens et al., 2003). According to transportation studies, residents in traditional communities—those with a higher residential density, a variety of land uses, and grid-like street layouts with small block lengths—take more journeys on foot or by bicycle than those of vast districts. They have further clarified that the main determinants of whether someone chooses to utilize motorized or non-motorized transportation are proximity (distance) and connectivity, which are two key features of how land is used (directness of travel).

In order to establish a connection between the built environment's condition and the amount of physical activity in light of the scientific evidence suggesting that physical activity, such as walking, may be beneficial to health, the multidisciplinary research on walkability first attempted to create a relationship between these two variables. Numerous studies in the fields of urban planning and transportation have looked at the relationship between community design elements and walking or cycling as a mode of transportation. They have consistently shown that individuals are more willing to walk and cycle through places that have a higher residential density, a diversity of land uses, and connected highways. Other elements, including the condition of the sidewalks, the presence of bike lanes, street design, traffic volume, and speed, are thought to be important, but they have not been well studied or demonstrated to have a significant effect.

While accessibility describes how simple it is to move between origins and destinations within the current street and sidewalk proximity refers to the distance between trip origins and destinations. When streets are organized in a grid pattern and there are minimal obstacles to direct passage between sources and destinations, connectivity is strong. Route distance is comparable to straight-line distance when connectivity is good. Grid patterns provide the option of choosing other paths to the same destination in addition to direct routes (Saelens et al., 2003).

The key elements to be examined, such as density, connectivity, and land use, have been identified by prior walkability studies using findings from transportation and urban planning research as a foundation. Existing research has discovered links between physical activity and mixed land use better connectivity(Soarnit& Crane, 2001; Crane, 2000;Maria Kockelman, 1997) ; and higher density(Soarnit& Crane, 2001)(De Certeau & Rendall, 2004). Population density is among the most consistently positive indicators of walking trips, according to studies that have looked at neighborhood features associated to walking rates. Greater walking rates among inhabitants observed to be correlated with the mix of land uses, particularly the closeness of nonresidential land use to other nonresidential land use and to places of employment(Maria Kockelman, 1997).

2.3 Existing approaches on walkability lack the clarity and specificity

Neighborhood comparison studies and correlational studies, which appear to have been influenced by the study methodology of transportation studies, have been the two primary approaches utilized in existing walkability studies. According to environmental factors, the community comparison studies examine the variations in walking rates among neighborhood residents. This strategy of choosing high- and low-walkability areas has been used extensively in earlier walkability studies conducted by preventive medicine to show how the built environment affects how much people walk. Additionally, some researchers have used quasi-experimental methods because it is impractical to run controlled intervention trials manipulating neighborhood constructed architecture (Wells & Yang, 2008);Cook et al., 2002). The other frequently used approach, correlational studies, makes use of analyses and regression models that give continuous measures of neighborhood characteristics and can quantify the relationship between neighborhood characteristics and non-motorized transport while controlling either or both of the individual and neighborhood sociodemographic variables that are known to be related to walking.

Although the earlier walkability studies were more driven by preventive medicine with the goal of providing evidence that the built environment does affect an individual's rate of walking, the input of knowledge from the urban planning and design field has become essential in order to develop the research in producing more specific knowledge in how different attributes of the built environment influences walking. Because of this, research on walkability is increasingly including urban planning and design, and studies are being actively carried out to demonstrate a relationship between various aspects of the urban form and walking. The combined impact of "bundles" or "packages" of environmental influences are also a topic of recent research (Vinemen et al., 2009). In addition, some research imply that characteristics other than the main ones that have been most consistently demonstrated may not have a significant impact on walking when taken into account in the context of accessibility provided by the mix of land uses and roadway network patterns (Wells & Yang, 2008). However, there are numerous unanswered issues about qualities that appear to be connected to physical activity, and further research is required to determine the strength of the association between minute measurements of the built and natural surroundings and physical activity (Rodríguez et al., 2006)

More in-depth understanding of urban form and the conditions of urban design is necessary to properly finish this sort of study and, equally essential, to be able to give helpful urban planning and design recommendations that encourage physical activity. This is not intended to refute medical science in any way. Instead, walkability studies offer a number of conclusions and a framework that can greatly aid in the study and practice of urban design, but which also has some limitations in terms of applicability. Once these limitations are addressed, however, such an approach may strengthen walkability research. Such approaches to urban form lack the clarity and specificity that may support real solutions since they are the outcome of broad measures that can support nearly any solution.

2.4 Identification of restrictions in walkability studies

The built environment is linked to people's physical activity and its influence on encouraging health, according to research from the medical sector. The research does have certain limitations, particularly when it comes to the built environment and walking habits. Due to a lack of understanding of the urban environment and its design, existing studies frequently miss identifying the questions and factors that are critical at the design level for the human-environment relations they are investigating, despite discussing the limitations of current walkability research. For instance, cross-sectional designs are often used in current studies on the environmental influences on physical activity behavior (Saelens et al., 2003).

It is frequently stated in published articles that the key challenge for research is to show that associations of environmental characteristics with physical activity behavior are actually causal and that future studies call for the use of prospective or intervention designs because cross-sectional studies do not establish causal linkage (Doeihmer et al., 2006) . However, as it is rarely feasible to carry out a proper experiment, this is an unavoidable constraint in research on the built environment. This would always be difficult. Additionally, building interrelations may be more crucial than establishing a cause-and-effect relationship in a stricter sense (Foucault, 1997; Tschumi, 1996).

In more practical terms, the problem is to identify elements that promote walking rather than encourage individuals to walk more frequently. Conscious choices, routines, social and cultural norms and circumstances, as well as other aspects of the built environment, will always interact to produce walking behavior.

The fact that walkability research is still in its early stages and that it is necessary to first provide evidence on whether or not walking behavior is affected by the built environment may be the reason why medical studies concentrate on proving the causal relationship between the built environment and walking activity. Given that the medical sector specializes in examining health benefits and that the nature of medical research necessitates vast populations to be researched in order to create scientific proof, medical research has really played a significant part in this endeavor.

The medical field is well-developed in providing design guidelines, but these are imprecise due to lack of knowledge about how the factors can be realized in built form. Current walkability research lacks systematic information about what may be the most effective approach to guide population-wide interventions, so future studies should focus on building knowledge about providing intervention guidelines. It is critical to deal with the small range of potential environmental elements in the research currently being conducted in order to create findings that might contribute to urban design standards. It is necessary to identify various elements more thoroughly. Enhancing the assessment of built environment qualities is important, in addition to better factor identification. In the medical sector, measuring techniques for environmental data were designed a priori rather than experimentally using factor analyses, based on prior findings, a conceptual model, and particular assumptions(Saelens et al., 2003). Research on walkability has significant challenges in measuring the built environment accurately and effectively. There is an urgent need for better identification and assessment of the built environment since the results of the current research lack comparability and transferability.

We thus need further information about the extent of the relationship between micro-level measurements of the built and natural surroundings and physical activity because the evidence now available raises several issues (Rodríguez et al., 2006). The area of urban design may be able to help with this progress. While efforts have been made to create lists or indexes of walkability (Ramezani et al., 2018; Ewing, 1999) , it's possible that more might be learned by expanding the field of study to include studies on walking, albeit caution must be used on the contributions it can offer. In this sense , Hillier and Hanson

(1989), in particular, employ an empirical-quantitative technique in the medical tradition, whereas (Gehl (2013) and Jacobs (1961) come from traditions that place a greater emphasis on qualitative approaches. While these point to a number of elements that are crucial for pedestrian behavior, they don't entirely answer the issues that walkability research has brought up. Other problems have also been addressed through refinements and further study, for instance (Mestford, 2010) , and in a larger context, the environmental design research offers numerous opportunities for knowledge, questions, and answers. Additionally, research using GIS tracking devices, a relatively new method to capture and aggregate data on people's walking patterns, might offer material and information that is crucial.

2.5 Assessment of environmental factors in walkability measures

It is crucial to enhance the assessment of environmental factors in order to perform studies on the association between built environment characteristics and physical activity more successfully. These environmental influences are assessed in contemporary studies in a variety of methods. For instance, the survey approach enables the researcher to gauge how the qualities of the built environment are seen. Unobtrusive indicators or measures, which enable data to be gathered without a person or a group of people being aware of it, are the other primary source of environmental measurements. They involve looking at things like physical conditions, historical materials, institutional data, and other private information. Regardless of the technique of data collection, systematic direct observations of physical environment elements inside communities have frequently been employed as a reliable approach, and the application of GIS technology aids in the mapping and analysis of data (Doeihmer et al., 2006) .

Observed and perceived environmental indicators are linked to physical activity behavior and obesity, according to recent research (Doeihmer et al., 2006). However, it is unclear whether different measurement techniques are reliable or which method is best for assessing how conducive a neighborhood is to physical activity. The optimum technique may not yet need to be determined, even if it is required to investigate the link between observed environment measurements and perceived environment measures in order to find reliable evaluations of neighborhood environments. Enhancing built environment measurement, whether it be from seen or perceived data, is more important. For instance, the observed data for the elements linked to physical activity, together with the methods used to observe them and the questions of the questionnaires used in the survey methods, should be further explored and refined. In order to best gather the required data, it is also important to design a technique for measuring the built environment, for which a specific type of observed data must be produced. In the case of perceived data, the content of the survey method's questions must also be improved. The concept of "border," or the area of a specified environment, is another crucial problem in assessing the built environment. The Modifiable Area Unit Problem affects walkability studies (Grasland et al., 2006). This is because research on walkability frequently contrast the characteristics and constraints of a location designated for uses other than walking.

Setting the boundary of an individual's environment for physical activity requires methods for aggregating street level data to take into account individual perceptions and re-define it using more precise locations in the urban fabric. Additionally, environmental data for respondents whose buffers extend outside the measured study area may be omitted if objective data measurements are only made inside the research area limits. As a result of recent technology advancements, the area of effect for each point may now be redefined by aggregating street level data based on distances from a single point (such as a plot or a building door). Integrating walkability research into urban design and urban design research has both benefits and drawbacks. Although the tools and understanding that urban design research offers are crucial, there are methodological and theoretical issues with how to apply this knowledge to the kinds of topics that walkability research seeks to address. Urban design research focuses on other aspects of walking, requiring translation and development rather than new models and methods.

One aspect of urban design study that use the same empirical-quantitative methodology as the medical sector focuses on collective behavioral patterns and how they interact with the physical environment. Such methods frequently concentrate on flows, levels of presence, the quantity of walkers, and how they alter place or space. These methods often consist of focused observational studies that look at the pedestrian flows in specific areas of the built environment. Although a lot has been learned about the various factors that affect how and where people walk, it has significant limitations: it fails to capture the meanings of rates or flows because it rarely captures many of the qualitative aspects of these flows and it says very little to nothing about specific routes or lengths of walks and walking routines. These studies range from more qualitative ones, like (Gehl, 2013), to ones that are rigorously statistical, like those in the topic of "space syntax" (B. Hillier, 2007).

These approaches have inherent issues when it comes to fundamental issues in walkability research, such walking lengths, recurrences, and routes, even if they provide a great deal of useful information about walking behavior. According to (Hayles, 1991;Lefebvre et al., 1996; Johnson, 2002) and others, the connections between individual behavior and communal patterns are complicated and not always obvious. Walkability research focuses on the experience of the walker, while other urban design research focuses on how walking forms narratives, generates impressions, and produces habits and identities. Despite not necessarily coming directly from the subject of urban design, they have a tendency to be more readily embraced, or at least accepted, by many designers since they take into consideration personal preference and experience. These methodologies offer plentiful chances to challenge, clarify, and improve the procedures and results of the quantitative research as well as, to a certain extent, the normative research that focuses on 'walkability'. The goal is to look at how walking may be made to be a richer experience when they are transformed into design standards, albeit this is not always the case.

Although it is sometimes believed that walking will increase, this is often neither the intention nor the claim. Additionally, if the results of the walkability research are accurate, this study appears to place more of an emphasis on walking activities than sociodemographic and other characteristics, which are less impacted by urban design and its long-term effects on physical activity. Such studies focus more on "pleasure walking" and less on "utilitarian" walking. However, the question of whether certain walking experiences have a greater influence outside of the specific activity itself than other types and so more strongly encourage walking rates indirectly might be questioned. Study on walking patterns and how they shape lived experience or life in general (Agoard, 2007; Lefebvre et al., 1996) appears to be of direct relevance within this very large topic of qualitative research. This type of qualitative study may resemble "walkability" investigation in that it exposes common behavioral patterns, but it differs in that it focuses on walking once individuals are actually doing it rather than on whether they should choose to walk over other means of transportation or not at all. The field of walkability research is a complex and rich one, with primarily qualitative studies not directly applicable to walkability research due to the nature of the questions and methods used. The translation from these primarily qualitative studies into urban design factors is complex and requires judgment calls, making it valuable in the design process but difficult to adapt for walkability research. However, actively using this sort of research and the findings from it in the development of research can provide valuable information, while recognizing differences and conflicts in both methods and purpose. This melding of approaches requires recognizing both as equals when it comes to the interchange between them. Walking behavior is an area where urban design research has both strengths and weaknesses. This suggests that there are methodological and theoretical problems with how to translate urban design knowledge into the kind of questions walkability research tries to answer. A richer understanding should better integrate the knowledge from the urban design field in the measurements and methods of walkability research, while taking the knowledge gained in the latter into account when developing the former. To become true, measurements, factors, and guidelines need to be more refined and sensitive to local situations and conditions, as well as different aims and intentions, in order to be of more value in the design process.

The medical approach and the urban design approach can be seen as complementing one another. Environmental design studies provide an interesting perspective on the relationship between built environment and behavior, as they apply the results, theories and techniques of behavioral and social sciences to address design problems and improve the quality of the resultant product. (Gehl, 2013) and the space syntax field have also been helpful in bridging the gap between research and design input.

3. The aspects of the relationship between walking and the built environment

The walkability research initiated by the field of preventive medicine has established that the built environment is one of the factors influencing walking behavior through correlation studies. However, little is known about how and to what extent it influences walking. This section offers observations on how to interpret and approach walkability, as well as the link between the two.

In walkability studies that compared the state of the built environment to the amount of time people spent walking, the concept of "walkable" is typically stated as "encouraging walking" or more particularly "raising the quantity of walking activity". This is because many of these studies were launched with the goal of improving persons' physical activity levels for health benefits. Of the literature and research dealing with the "pedestrian-friendly" environment from the urban design and planning sector, it appears that the strategy in how to "support" and "enrich" walking activity is frequently discussed. These definitions give the impression that they investigate the built environment's ability to facilitate walking. This is largely correct, but keep in mind that having the ability to promote also implies having the ability to discourage walking. The use of such a phrase reversal becomes evident when the context in which the area of preventive medicine began to conduct walkability research is recognized. While many of these studies are from North America, the locations are frequently the troubled suburbs generated by severe urban development, which are heavily reliant on autos. They are areas where urban expansion has resulted in the establishment of an environment in which walking is not considered a viable or feasible means of transportation. In other words, these research are looking at urban environments that make walking difficult or impossible. Many of the neighborhood comparison studies from these settings, in which areas with high walkability and low walkability are contrasted, show not how communities with high walkability encourage walking, but rather how neighborhoods with poor walkability prohibit walking (Gallimore et al., 2011).

Walkability studies explore the built environment factors that impede walking activity and present explanations for why and how these circumstances should be avoided. They also look at the minimal environmental parameters that need be maintained in order for individuals to choose walking as a form of transportation. These studies frequently look at how unwalkable a place is rather than how walkable it is, and they educate us what not to do. When it comes to encouraging people to walk, the physical environment has minimal influence because it is governed by a range of elements such as individual motives, demographic characteristics, and social context. When it comes to impeding walking, the built environment can become the deciding factor if the walkability criteria are to the point where the environment prohibits walking, independent of the other variables influencing humans' decision-making process. It is critical to investigate the built environment as a component of walkability and to learn ways to avoid producing unwalkable urban areas. The built environment is a factor over which the individual has no control and which has a long-term impact on a vast population.

3.1 The impact of built environment on walking

The importance of the environment in influencing walking in terms of permitting or not allowing walking is primarily concerned with the influence of the built environment in the decision-making process. The majority of walkability correlation studies measure and analyze the quantity, and very often the total amount of walking activity. However, such an approach may be limited in its ability to capture the entire scope of the built environment/walking interaction. When the scope of the built environment's effect on walking activity is widened, there are features of the urban environment that may be defined more precisely in terms of influencing the 'quality' of walking activity (Brown et al., 2008).

The frequency with which the walking activity occurs may be more important than the quantity of walking. As a result, the amount of walking is determined by the number of occurrences of walking, therefore the decision-making process of whether to walk or not becomes the primary worry when examining this aspect. And, as previously noted, the allowing or disallowing effect of the built environment reflects the function of the environment in the decision-making process that happens prior to the actual walking action. However, as previously said, the constructed environment is the setting for the walking action.

As a result, the relevance it has on walking activity is that, once walking activity occurs, the state of the built environment is frequently the main element influencing the quality of the walking activity, deciding how convenient, enjoyable, entertaining, and safe it becomes. Regardless of how influential the condition of the built environment is among the various intra- and extra-personal factors in an individual's decision-making process, once the walking activity occurs, the quality of walking is intrinsically tied to the condition of the built environment, as it serves as the physical context for the walking (Jakobsson, 2009).

As a consequence, it might be proposed that the many ways in which the built environment impacts walking behavior can be classified as either having a more direct influence on the amount or quantity of walking or having a more indirect influence on the behavior by changing the quality of the activity. The correlation studies from walkability research based on public health objectives discovered factors that are more directly engaged in substantially impacting the quantity of walking activity. The primary elements in this quantitative aspect are those that contribute more directly to supplying destinations (e.g., through high levels of land-use diversity and density) and those that contribute to practicable and convenient access to these destinations (Cook et al., 2002).

However, there are certain aspects of the built environment that do not have as large impacts but have a more direct impact on the quality of pedestrian activity. They include urban design features, and while they have been proven to be less relevant in walkability correlation studies, they have received less attention in recent walkability research due to the difficulties in linking them to the quantity of walking. As a result, while the urban design conditions that are better described as influencing the quality of walking are more frequently discussed in the literature and recommendations from the field of urban design and planning, these factors have been considered as less significant in walkability correlation studies. Nevertheless, while these characteristics may be less powerful in influencing the quantity of walking than the key walkability factors found in these research, they may still have an indirect impact. The amount of quality of prior walking activities experienced by individuals may impact their decision to walk, especially when impressions are collected.

The built environment is a major factor determining the quality of walking activities, regardless of the issue on promoting or increasing the amount of walking. It is important to develop knowledge that investigates and explains how various conditions and design qualities would affect walking activities, either enhancing or decreasing it. The built environment can influence walking activity in both quantity and quality, (Gallimore et al., 2011) but some factors may be strong in one aspect but not as much in the other. For example, land-use diversity and density are important factors in relation to the experiential quality of walking, as the results of the observation study from this project indicate.

This classification of the ways in which the built environment influences walking is useful in understanding the different stages of how individuals conduct the decision-making process and the actual walking. Factors that are more influential in the process of making the choice to walk are those related to the quantity of walking. The built environment's influence on the decision-making process is moreimportant than the quality of the walking, as it comes into effect once the individual starts walking. The result of the later stage may also influence the choice of walking as a feedback process.

3. 2 Integration of Walkability in urban design

The built environment's impact on walking behavior may be studied and investigated on several levels or sizes. The physical environment-related walkability factors discussed in various studies and literature range from the regional planning level, such as the provision of public transportation, to the urban planning and design level, such as density and land-use diversity, and down to the micro-level of urban design and architecture. (Gallimore et al., 2011)This is evident in both the measurement of built-environment variables linked to walkability and the intervention proposed to improve walkability (Werner et al., 2010).The measurement and proposed improvement for these characteristics frequently function on a local scale. And, in terms of primarily dealing with the quantity of walking, it is possible that this level best represents the most relevant aspects (Ramezani et al., 2018). Even though this research study addresses walkability elements at the urban planning level as well, one of its primary goals is to investigate walkability aspects at the urban design level(Tsiompras, 2018). The urban design level has, relatively speaking, not yet been adequately examined in both walkability studies dealing with the quantity of walking and urban design ideas on pedestrian-friendly design (Park, 2008). While the main factors mentioned above are generally measured and discussed at the neighborhood scale, the attributes measured or discussed at the micro-level of urban design and architecture are frequently limited to design qualities such as street width, aesthetics, landscape design or street furniture (Park, 2008) . And, as discussed in the previous chapter, these factors are frequently the ones primarily discussed in urban design literature, although the evidence supporting the recommended guidelines for these factors, as well as the validity of their influence on walking behavior and applicability, must be carefully considered.(Gehl, 2013). What appears to be lacking in current walkability research is an examination of built environment attributes at a more detailed urban design scale, as well as the provision of better evidence for design qualities, including both those mentioned above and others less explored.

The primary walkability elements should be monitored and researched more thoroughly at both the street and neighborhood levels to have a better understanding of how and why they impact walking behavior. Furthermore, the research of these characteristics at the urban design and architectural levels is significant, because how they are applied at this granular level by design may impact how successful they are in influencing pedestrian behavior (Gori et al., 2014). For instance, even if the degree of land-use diversity or density measured at the area or neighborhood level is the same, the effectiveness of their influence on both the quantity and quality of walking activity may differ slightly depending on how they are designed at the street and building level in accordance with the qualities, such as ground-level design, number and position of building entrances, design related to sidewalk-ground level.(Soarnit& Crane, 2001).

3. 3 Characteristics of walkable built environment

Non-motorized means of mobility, such as walking or cycling, rely heavily on urban form. It also benefits economic, environmental, and social objectives. In contrast, urban patterns centered on vehicle traffic have discouraged adults and children groups from walking for a variety of reasons, including growing parental worry about their children's safety on hazardous streets. Low walking levels have been confirmed in communities with "*low density, poorly linked street networks, and inadequate access to stores and services*" (Gorti, 2006). In this regard, a number of research projects have been done to establish new urban form strategies that give more walkable urban space opportunities, as well as public transportation options, as an alternative to car-dependent urban space production methods. According to researchers such as McDonald et al., (2008) , "both material infrastructure (urban form) and collective social functioning" define the urban elements that create healthy urban forms for urban society:

Physical features of the environment:

- Home, work and other urban settings utilized in people's everyday activities
- Public or private services which assist daily lives of people
- The socio-cultural qualities of the neighborhood. (McDonald et al., 2008).

Similarly, the link between urban form and travel behavior is significant for three key reasons:

1) To comprehend the relationship between urban form and non-motorized transportation;

2) To demonstrate the complexity of travel behavior as it relates to not only urban form, but also socioeconomic and demographic values influencing travel patterns; and

3) To clarify the patterns that promote walkability.

It is necessary to invest in public transportation infrastructure in order to achieve a walkable urban form. However, this is insufficient to influence travel behavior in a sustained manner. It seeks both'macro' land use rules and'meso-scale' local planning requirements. These ideas have the potential to augment and help the transportation network. Major actions must be correctly tied to one another. People should be able to easily go to their everyday destinations by using public transportation, walking, or cycling. As (Kennedy, 2019) explains, "*The devil is in the details, and the details start with the design of streets and communities*". As a result, there may be a movement to restore some of the spatial characteristics of traditional neighborhoods, and these groups refer to this new approach as the neo-traditional community plan.According to (Friedman et al., 2012), the neo-traditional neighborhood plan may reduce the need for personal motorized cars. It ensures dense mixed-use districts with a well-defined pedestrian and bicycle route network. Streets are meant to reduce the number of automobiles on the road.

Other scholars are looking at the link between walkability and urban form at the meso-scale in addition to the neo-traditional neighborhood design. Newman, for example, emphasize New Urbanismrecommends a neo-traditional design approach; Arthur et al., (2014) propose a 'New Pedestrianism' approach; and so on. The section that follows looks at several approaches to neighborhood planning. All of these strategies strive to create more pedestrian-friendly surroundings. This section intends to highlight the common design parameters by evaluating different techniques (Table 1).

Tableau 1 The most modern design techniques for creating walkable communities or urban areas
Source: (Newman & Waldron, 2012)), and (Arthur et al., 2014).

New Urbanism	The urban system is defined through a transit system, a high-density urban form and mixed land use. Features: • Compact and mixed development • Density averaging at least 15 units/ha • A variety in the built-up area (small-lot family, multi-family, residential over retail and various commercial and institutional structures close together) • Dwelling within a five-minute walk from the centre • An elementary school in 1.6 km radius • Highly connected street networks • Minimum parking lots • Parks and playgrounds not more than 200 m from each dwelling (Schiller et al., 2010)
Urban village	A settlement created on a green field or brownfield site, or out of an existing development. Features: • High density • Mixed use • Mix of housing tenures, ages, and social groups • High quality • Being based on walking (Jabareen, 2006)
Transit oriented developments (TODs)	Same as "Transit village", "transit-friendly design" and "transit supportive development" Features: • Walkable and mixed-use neighborhoods (within 600 meter walking distance) • Urban street pattern with great street connectivity (Cervero, 2008) • Corridor-based urban form with TOD foci • Compact, mixed-use development around transit stations • Pedestrian-friendly design • Parking availabilities (cars and bicycles) • Parking access management (Appropriate parking standards, structured parking facilities and on-street parking issues should be considered)
Pedestrian-friendly design	• Land use functions along streets • Pedestrian routes along the street network • Narrow streets • Accessible streets from every point and visible • Short and direct routes for pedestrians and cyclists (Guiding Principles for Creating Transit Station Communities, Puget Sound Regional Council)
New pedestrianism	A settlement designed as either car-free or having car access to the houses with pedestrian lanes in their front. Features: • Walking and cycling are encouraged with tree-lined pedestrian lanes with 5 meters width and a smooth side for cycles, skaters and others. • Car circulations are served on a separate network (http://michaelearth.com/introspective.htm)

4. Conclusion

According to this survey of literature, the study of walkability is one of the fastest developing integrated concerns in urban design, urban planning, transportation planning, architecture. The integration of multiple disciplines provides a useful starting point for interdisciplinary research on walkability. Furthermore, combining multiple disciplines protects the future performance of sustainable urban management. Furthermore, this connection allows for greater combination inside and across modes of transportation. These works of literature will serve as a foundation for more contemporary efforts to create recommendations for a walkable environment. While the problem of pedestrian-friendly design continues to gain attention, there are publications that have been critical in supporting the necessity of addressing the pedestrian and offering information about street usage, such as the work of Appleyard, Whyte, Lynch, and Jane Jacobs. As indicated in the discussion of walking-friendly urban design principles, the discourses and ideas from the urban planning and design literature are largely lacking in evidence when compared to statistical analyses of contemporary walkability research. They are largely based on specialist knowledge or basic, non-systematic observations, and as a result, several facts of pedestrianfriendliness contradict each other throughout works of literature and partially contradict the conclusions of modern walkability research. However, when compared to statistical analyses on walkability, these works of literature provide deeper insight into why and how the urban environment may encourage walking. Some of the primary ideas and arguments from these works that give knowledge that may aid in the understanding of walkability will be discussed in the coming chapters.The walkable environment has many benefits, such as physical health, psychological benefits, social benefits, and potential health benefits. However, the empirical study of this project suggests that if the aim is to encourage walking through the built environment, the focus should be more on the aspect of walking as a social activity.Planning and designing an urban environment that offers pedestrians greater opportunities for spontaneous exchanges with other people, activities, objects, or buildings is an important strategy for creating an environment that offers a greater amount of walking destinations and improves the experiential quality of walking activities.

CHAPTER TWO

STREET NETWORK DEVELOPMENT AND MORPHOLOGY

1. Introduction

Cities have urban design aspects that differentiate and characterize them. Street networks, which are fixed in space and offer geometry to cities, are one of the urban form features that provide structure to cities. Several research explains why the street networks were discovered to have a relationship with changes in commuting among inhabitants. These shifts can be attributed to changes in social and economic demography, as well as culture and the physical environment.

Street networks serve as the foundation upon which we create communities. Good street network designs conserve land, promote accessibility through more direct routes, and improve overall network efficiency and dependability through redundancy. They also have an impact on various variables related to the development of more sustainable communities, such as travel patterns, road safety, and public health.

The science of networks has seen a tremendous boom in recent years. Advances in statistical physics and the study of complex systems, that is, systems with numerous interconnected components whose interactions cause unforeseen large-scale emergent phenomena, have fueled much of this research. Cities are complex systems that emerge from both decentralized, bottom-up, self-organizing processes and top-down planned interventions. Humans both shape and are shaped by their urban ecosystems (the physical environment, institutions, cultures, and so on). Cities are made up of many interconnected components that interact via networks - social, virtual, and physical - such as street networks. Street network analysis has always played an important role in network science, especially during the last fifteen years who has experienced an expansion of multidisciplinary network research including several applications to cities and their street networks. These investigations have resulted in new insights into urban shape and design, transportation flows, accessibility, topology, and durability of urban street networks. However, present data availability, consistency, and technological restrictions have resulted in four significant flaws: limited sample numbers, excessive network simplification, problematic replication, and a lack of consistent, user-friendly research tools. While these flaws are not catastrophic, they do restrict the scalability, generalizability, and interpretability of empirical street network research.

This chapter introduces the theoretical background of street networks, their structural complexity, form, and how they are shaped by planning periods and design ideas. In this work, we focus on the way in which how road networks have been instrumentalized to provide favorable conditions for individuals. the term traffic includes walking and biking, Public transport traffic is not addressed because it has particular issues. In this chapter, we will offer an overview of the variety of urban planning recommendations for the design of street networks. These recommendations have been divided into three paradigms which we believe have guided the process, from antiquity to the end of the twentieth century, when street networks were designed according to three paradigms: the street network as the image of the city, the street network as a place to live, and the street network as a traffic carrier.

2. Urban planning and design of road networks

The design of road networks in urban planning is an intentional process. At different times in history, urban theorists and practitioners have instrumentalized road networks to bring out qualities that were considered desirable in their time. For example, they have designed regular road networks to produce an image of order in the city, and networks with curved paths to produce a bucolic image, (Alonzo (2018). The creation of favorable traffic conditions is one of the main intentions of urban theorists and practitioners when designing networks. The architect Jean-Nicolas-Louis Durand argued that communications in the city should be as short and convenient as possible and that straight streets should be designed , (Alonzo, 2018). The architect Le Corbusier stated in 1925 that his machine city should be reticulated by "another type of street", a "machine for circulation" and a "factory whose tooling must realize the circulation" (Alonzo, 2018).

Thus, theorists and practitioners of urban planning make suggestions on the design of road networks enabling good conditions for traffic for users. These problems often have a reproducible vision. Antoni, (2016) argues that the choices and policies of planning and transport policies fall within the field of convictions, and Françoise Choay, (1965)explains that the recommendations made in urban planning are subordinated to ethical choices, and purposes that do not belong to the order of knowledge.

Ethical and political convictions and choices are an integral part of the recommendations made by urban theorists and practitioners. However, a number of authors are critical of this process of constructing recommendations, as it undermines the scientific status of urban planning. Among these authors, the urban planner Randall Crane, (1996), who examines a set of proposals made by the New Urbanism to improve traffic by acting on the road network of cities, Ghorra-Gobin, (2014). Crane, (1996) argues that, while these proposals may have merit in some cases, each of their components may also have negative effects on traffic. He adds that this possibility is largely absent from the texts describing these proposals. He concludes that "*The important thing is that more knowledge is developed, in order to avoid situations where the development of a new urban style unintentionally causes more traffic problems than it solves*". The lack of evaluation described by Crane, (1996) for some of the work to improve traffic conditions contrasts with the fact that the study of traffic is well-established.Indeed,

Since the 1920s, several practitioners and researchers have made intra-urban traffic their specialty, forging theories and methods that have given rise to the study of urban mobility (Commenges, 2013).

The recommendations of urban planning theorists and practitioners in relation to road networks can refer to different components of these networks: their morphology, the arrangements to be made on these networks (sidewalks, urban furniture,…), or even the regulations governing their use (for example the type of authorized vehicle on each lane), (Alonzo (2018). In this chapter, we will focus on recommendations on the morphology to be attributed to networks, in other words to the elements that can be represented on a plan (the tracks and their arrangement, and the junctions between them). This choice is motivated by the fact that morphology is often at the heart of the area of competence of urban planners and practitioners, as opposed to network development, or the regulations governing its use, which often depend on other bodies of trade. We also choose to designate the traffic conditions available to users by the expression "*accessibility conditions*", which correspond to a set of possibilities offered to users during their travels, and which allow them good access to their destinations. This concept of accessibility allows us to specify that our interest relates to the travel offer provision of individuals, and not to the actual mobility behavior of these individuals, in other words, we are interested in the conditions of accessibility offered by street networks to individuals when they travel.

3. The historical evolution of street networks

The historical progression of street networks reflects the dynamic evolution of urban landscapes, adapting to changing societal needs and technological advancements across diverse civilizations. Ancient civilizations, such as the Mesopotamians and Egyptians, demonstrated early street layouts as a fundamental aspect of urban planning, illustrating adaptation to local geography and social structures (Benevolo, 1980). The Greco-Roman period saw the establishment of well-organized cities with grid-like plans and axial streets designed to showcase grandeur and efficiency in movement (Gyug, 1996). Moreover, during the Middle Ages, the organic growth of European cities resulted in labyrinthine street patterns dictated by functional necessities, religious considerations, and defense strategies (Mumford, 1961).

With the Renaissance and Enlightenment eras emerged a renaissance in urban planning, notably characterized by city designs focused on aesthetic principles, public health concerns, and rational geometry. Cities like Paris under Baron Haussmann's transformations introduced wide boulevards, promoting circulation, hygiene, and social control (Gans, 1991). In the industrial era, rapid urbanization and the influx of populations into cities led to the implementation of gridiron street layouts in many

North American and European cities, reflecting the need for systematic planning to accommodate burgeoning populations and industrial activities (Jacobs, 1961).

Looking ahead, contemporary urban planning endeavors prioritize sustainability, resilience, and inclusivity in street network designs. Concepts such as "New Urbanism" emphasize mixed-use developments, compact neighborhoods, and connectivity to encourage walking and reduce automobile dependency (Duany et al., 2000). The evolution of transportation infrastructure, such as the advent of electric and autonomous vehicles, is poised to revolutionize street networks, aiming for smarter, more adaptable urban layouts (Cugurullo, 2018). These innovations seek to create dynamic urban environments that seamlessly integrate technology, public spaces, and green infrastructure, envisioning cities as vibrant, interconnected hubs that prioritize environmental harmony and human well-being.

The historical evolution of street networks can be divided into different phases, depending on the geographical, cultural, and technological factors that influenced their development. Here is a brief summary of some of the main phases:

3. 1 Ancient street networks

These are the oldest forms of street networks, dating back to the origins of urban settlements in ancient civilizations such as Mesopotamia, Egypt, China, India, and Greece. Ancient street networks were often irregular, organic, and adapted to the natural terrain and the local needs of the inhabitants. Some examples of ancient street networks are the labyrinthine streets of Babylon, the orthogonal grid of Mohenjo-daro, and the radial pattern of Rome (Southworth& Ben-Joseph, 2003; Strano et al., 2012).

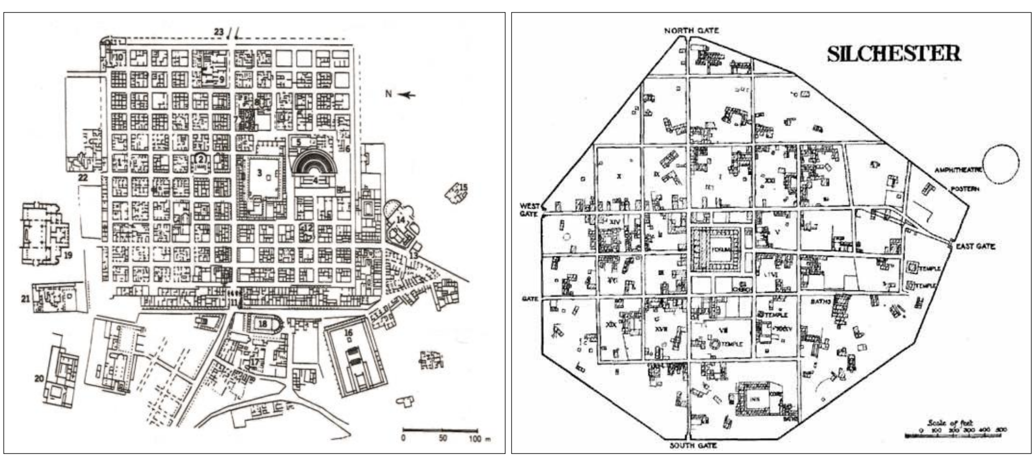


Figure 1 Ancient Roman Metropolis.source: Grimal (1983

3. 2 Medieval street networks

As populations swelled within fortified medieval settlements, the limited land area forced increasingly dense street patterns (Lilley, 2012). Roads and alleys varied from a few feet to twenty feet wide but most lacked systematic hierarchies or widths. Street uses overflowed chaotically as markets, processions, animals, and artisan shops cluttered roadways. However by the 13th century in Europe, city administrators began issuing decrees to organize widened main thoroughfares for commerce and military needs, regulate encroachments, and zone different quarters – though most districts remained cramped mazes (Alsayyad, 2014). As civic projects, main streets were paved, integrated drainage infrastructure and later street lighting. But minor streets remained dark, unsafe and filled with refuse until later years.

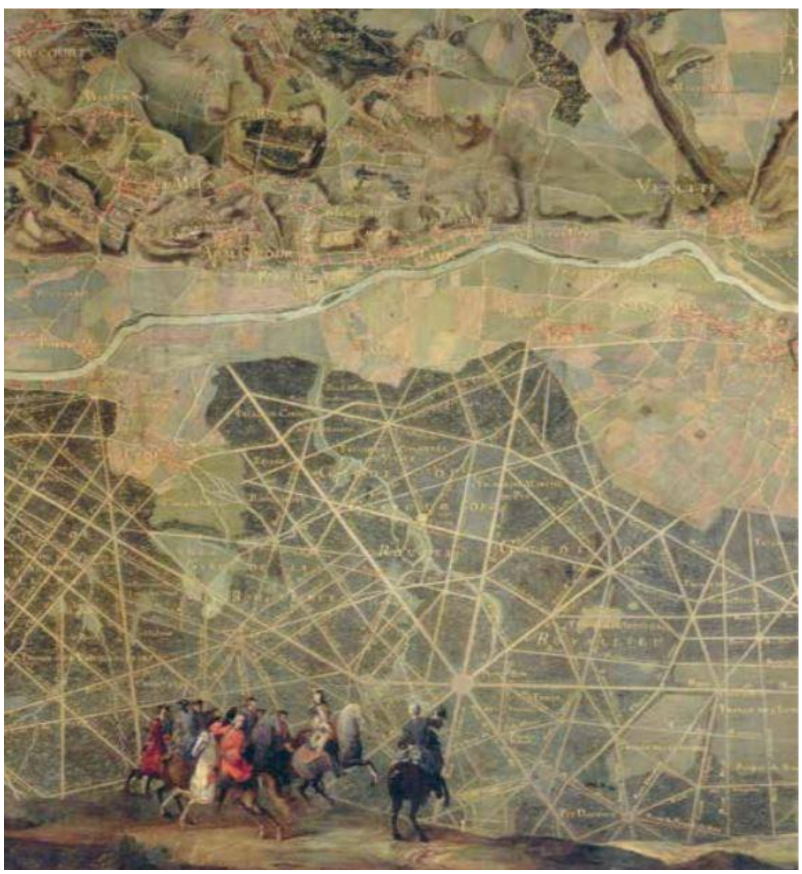


Figure 2 Plan of the Compiègne forest.
networks made of beams and wefts of straight lines forming star-shaped figures. source: (Alonzo, 2018)

Figure 3 The Medieval City Plan Generator of European city showing the street network. source: (wtabou, 2019)

3. 3 Renaissance and Baroque street networks

The street networks that developed during the Renaissance and Baroque periods, from the 15th to the 18th century CE, in Europe and its colonies. Renaissance and Baroque street networks were characterized by the introduction of geometric order, symmetry, and monumentality, inspired by the classical ideals of beauty and harmony. Some examples of Renaissance and Baroque street networks are the star-shaped plan of Palmanova, the grand boulevards of Paris, and the radial avenues of Washington, D.C. (Southworth& Ben-Joseph, 2003; Strano et al., 2012).The Baroque period brought a wave of state-sponsored street improvements across European cities like Paris and Rome along with expansions, demolitions and reconstructions aligned to grandeur visions (Moudon, 1997). Boulevards widened medieval walls into linear public spaces connecting hubs while long tree-lined axial avenues imposed order over more organic fabrics. The results afforded majestic vistas, military control and fire protection but also displaced residents. These interventions established templates adopted globally through colonialism. Urban renewal programs accelerated in the 19th century, bulldozing smaller streets for grander redesigns. The long-term impacts on traditional neighborhoods were immense, seeding criticisms. As the 19th century unfolded, urban renewal initiatives gained momentum, marked by the deliberate demolition of smaller streets to pave the way for grander and more extensive redesigns. While these transformations aimed to modernize and reinvigorate urban areas, their long-term impacts on traditional neighborhoods were substantial, giving rise to substantial criticisms and social upheaval. The legacy of these sweeping alterations remains an integral part of architectural history, serving as a critical lens through which to comprehend the evolution and challenges of urban development and renewal.

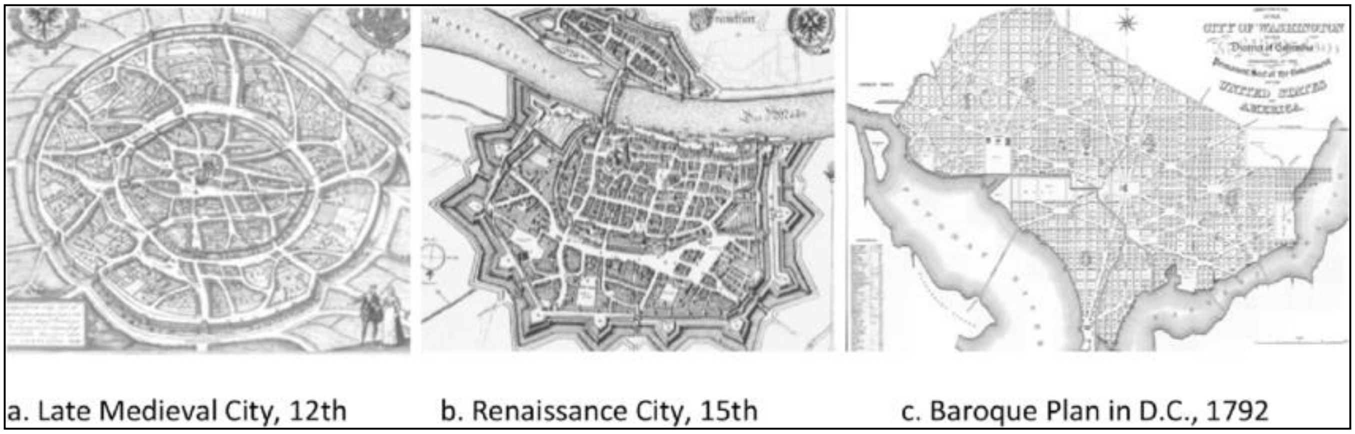


Figure 4 Medieval, renaissance, and baroque city plans. source: Cuthbert (2006).

3. 4 Industrial street networks

Street networks that emerged during the Industrial Revolution, from the 18th to the 19th century CE, in Europe, North America, and other parts of the world. Industrial street networks were influenced by the rapid urbanization, population growth, and technological innovations of the era. Industrial street networks were often regular, grid-like, and expansive, facilitating the movement of goods and people and the provision of infrastructure and services. Some examples of industrial street networks are the checkerboard plan of New York, the ring road of Vienna, and the garden city of Letchworth (Southworth& Ben-Joseph, 2003; Strano et al., 2012).

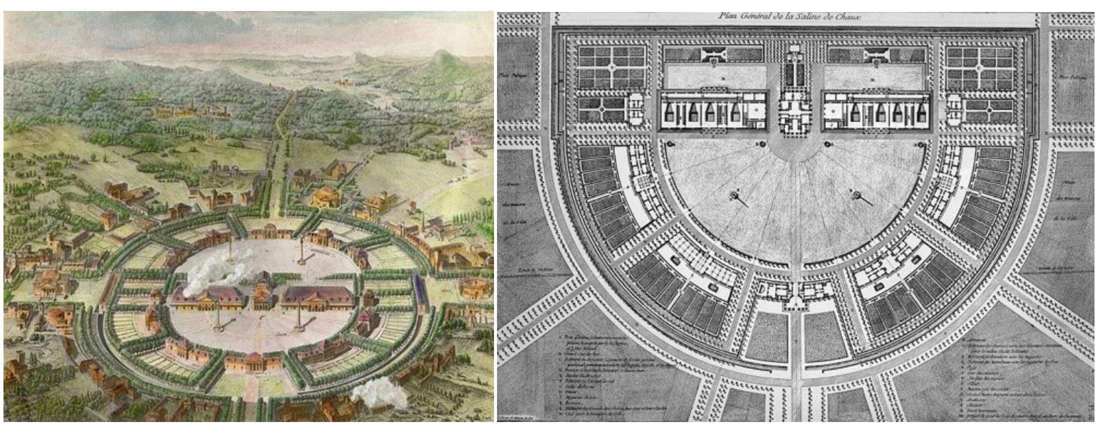


Figure 5 Left : la cité ideale des chaux (by Ledoux 1779).

The Industrial Revolution fundamentally reshaped street usage and infrastructure. The proliferation of omnibuses, trams, and railways running through city streets catalyzed a new built-form orientation suiting mechanized transport. Cobblestone paving gave way to macadam and wooden blocks; bridges improved for heavier loads (Loukaitou-Sideris, 2019). Streets were incrementally widened, straightened, and connected to better facilitate mobility while their users diversified from pedestrians to multiple vehicles. Subterranean subways further expanded transport capacities beneath 19th-century metropolises as overpasses allowed separating grade trains from other traffic. The cumulative transformations enabled urban life and growing economies to flourish but compromised old streetscapes.

Figure 6 The Place de l'Etoile in Paris.
Source (Prouteau et al., 2013)

Figure 7 Early 20th century car in Paris.
Source: (*Les Voitures à Paris Au XXème Siècle – Paris ZigZag | Insolite & Secret*, n.d.)

3. 5 Modern and postmodern street networks

The evolution of street networks in the 20th and 21st centuries has been shaped profoundly by the multifaceted challenges posed by modern and postmodern societies. These networks, in response to the intricate interplay of social, economic, and environmental demands, have undergone a metamorphosis, displaying diversity, complexity, and dynamic characteristics. They vividly mirror the diverse urban landscapes and their multifunctional aspects, adapting continuously to the ever-changing needs and preferences of city inhabitants.

Within this context, various examples exemplify the spectrum of modern and postmodern street networks. For instance, Brasilia, with its hierarchical layout, symbolizes a deliberate and structured urban design that aims to optimize functionality and efficiency. On the other hand, Curitiba showcases an organic pattern, embracing a more fluid and adaptive approach to urban planning, emphasizing sustainability and integration with the natural environment. Meanwhile, Tokyo represents the network city concept, a highly interconnected and multi-nodal system, fostering versatility and accessibility across its vast urban expanse.

Grid networks, distinguished by their consistent and interlinked street arrangements forming a structured grid, exemplify a standardized and systematic layout conducive to efficient navigation and accessibility (Marshall, 2004). The hallmark of these networks lies in their uniformity, presenting a series of intersecting streets forming right-angled configurations, promoting high connectivity and straightforward travel routes. This well-organized design fosters ease of movement and aids in optimizing navigation within urban landscapes (Marshall, 2004).

The prevalence of grid networks is notably observed in cities renowned for their orthogonally aligned street patterns, such as the iconic urban settings of Barcelona and Manhattan (Porta et al., 2006). These cities serve as prime illustrations of meticulously planned grid systems, each reflecting an intentional and structured approach to urban design. The orthogonal layout of streets in these urban centers exemplifies a deliberate effort to enhance urban functionality, providing a harmonious blend of efficiency, accessibility, and aesthetic appeal (Porta et al., 2006). The systematic arrangement of streets in these cities stands as a testament to the deliberate planning and vision that underpin the creation of highly navigable and accessible urban environments.

Figure 8 The Plan Voisin, a project for the centre of Paris.machinsation of the street network. Source: (*Le Plan Voisin, Le Corbusier – Recherche Google*, n.d.)

4. Types and Characteristics of Street Networks

Street networks exhibit various types and configurations based on their design, layout, and connectivity patterns. Understanding these types and characteristics is fundamental to urban planning and transportation studies (Buhl et al., 2006).

4.1 Hierarchical Street Networks

Hierarchical street networks epitomize a structured arrangement of streets with diverse capacities and designated functions, typically organized in a hierarchical order. These networks intricately comprise primary arterials, secondary arterials, and local streets, each serving specific purposes and accommodating varying levels of traffic and activities (Hillier, 1996). This systematic layout aims to optimize traffic flow, accessibility, and urban functionality within a city.

In the context of the United States, cities like New York exemplify this hierarchical grid network. The city's layout showcases a clear distinction between primary avenues, such as the iconic Fifth Avenue, serving as major thoroughfares with high traffic capacity and significant commercial activity, and secondary streets like West 23rd Street, designed to support a slightly lower traffic volume while still maintaining connectivity within the urban fabric (Louf&Barthelemy, 2014).

These hierarchical networks not only facilitate efficient vehicular movement but also contribute to the overall spatial organization, enabling effective zoning and land use planning. They play a pivotal role in shaping the urban landscape by delineating areas for commercial, residential, and recreational purposes, contributing to the functionality and aesthetic appeal of cities. Such structured street networks embody a deliberate urban design strategy aimed at enhancing mobility, connectivity, and urban livability while accommodating the diverse needs of a bustling metropolis.

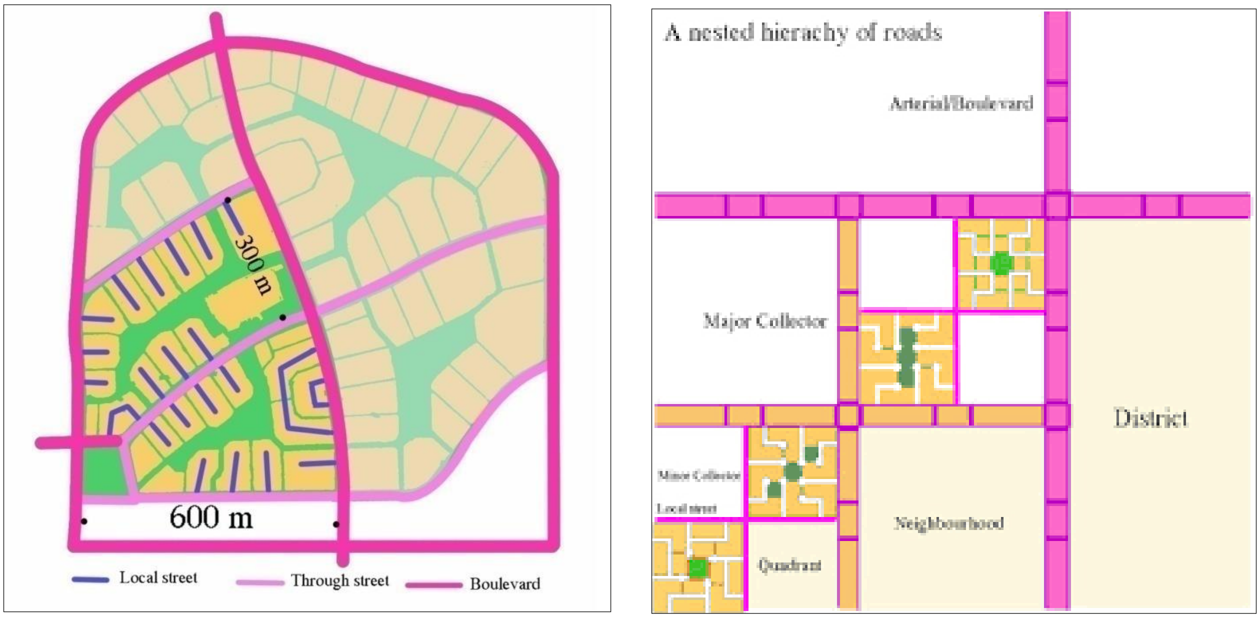


Figure 9 Hierarchical Street Networks. Source: (Google.2022)

4.2 Grid Street Networks

Irregular networks, characterized by their absence of a discernible pattern, frequently emerge due to organic evolution, historical legacies, or geographical limitations. These networks, devoid of a clear structure, often pose navigational challenges while simultaneously embodying distinctive character and embracing diversity within their design and layout (Louf&Barthelemy, 2014). Their origins can be traced to diverse factors such as haphazard growth over time, ad hoc expansions, or constraints imposed by natural topography. The idiosyncratic nature of irregular networks renders them intriguing and unique, showcasing a blend of historical heritage and urban evolution. Notable instances of such networks are evident in the labyrinthine medieval street configurations found in iconic European cities like London and Rome. These historical urban landscapes bear witness to the organic development and cultural influences that have shaped their intricate and meandering thoroughfares, resulting in complex and captivating spatial structures that intertwine history, culture, and urban functionality.

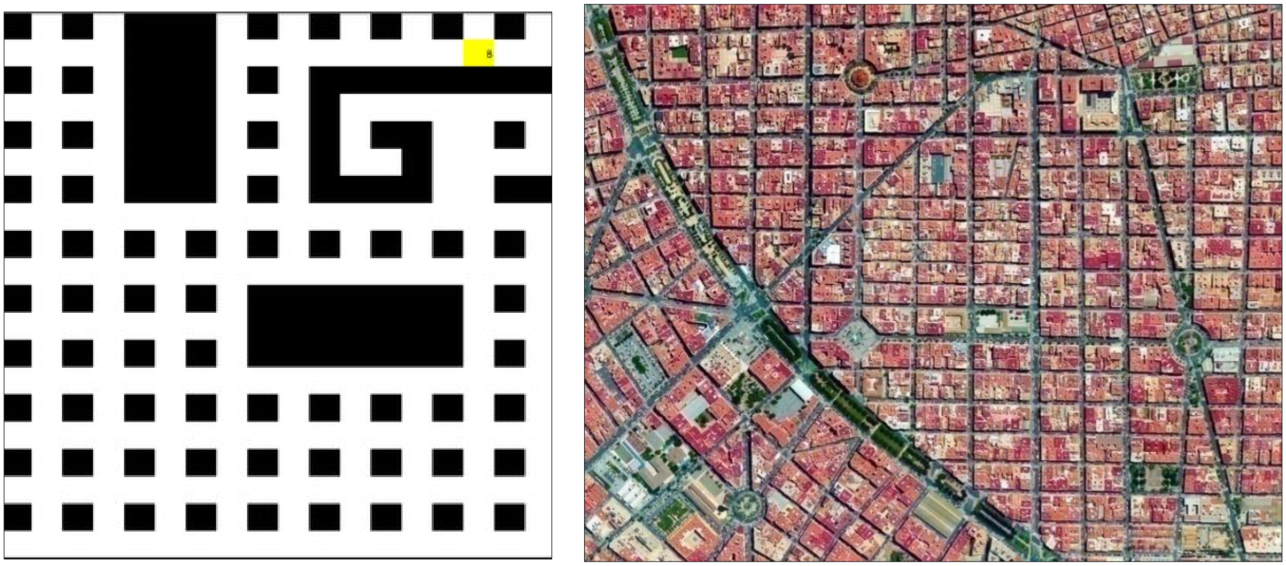


Figure 10 Orthogonal grids and their variations. Source: (Google.2022)

4.3 Radial Street Networks

Radial networks radiate from a central point, often a landmark or focal area, extending outward like spokes on a wheel. These networks are prevalent in cities designed around central squares or historic cores (Batty, 2005). Examples include Paris with its radial layout emanating from the Notre-Dame Cathedral.

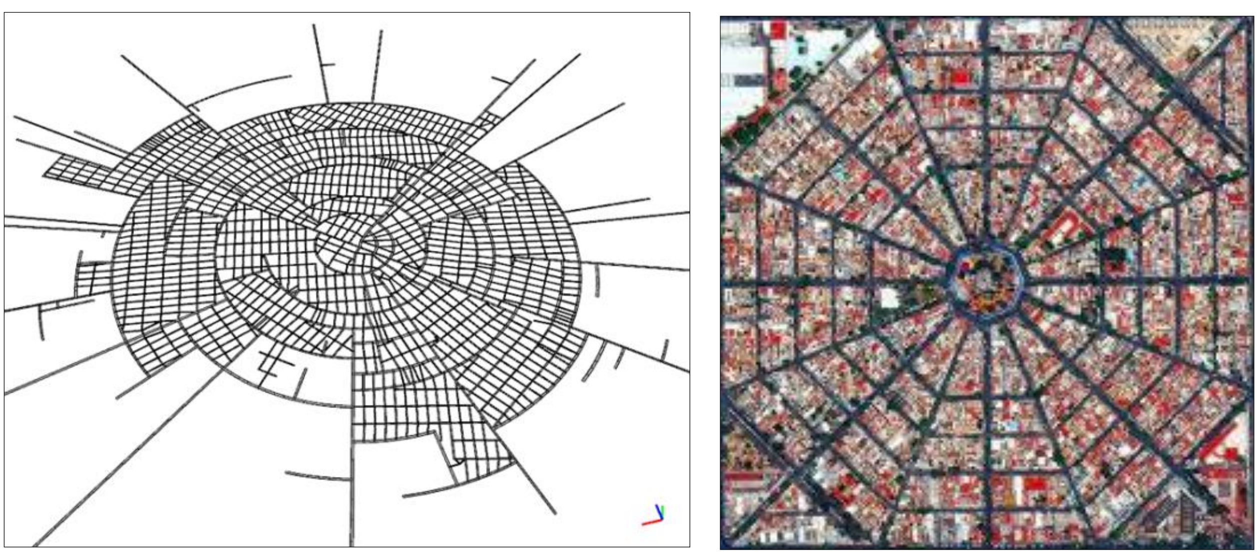


Figure 11 Radial street networks.Source: (Google.2022)

4.4 Cul-de-sac Street Networks

Cul-de-sac networks consist of dead-end streets culminating in loops or turnarounds. These designs prioritize localized access while limiting through traffic, promoting a sense of community and safety (Ewing & Handy, 2009). Suburban neighborhoods in many cities, particularly in North America, often adopt cul-de-sac patterns (Southworth& Ben-Joseph, 2003).

Figure 12 Cul-de-sac Street Networks. Source: (Google.2022)

4.5 Irregular Street Networks

Irregular networks lack a distinct pattern and may result from organic development, historical influences, or geographical constraints. Such networks often present challenges in navigation but may offer unique character and diversity (Louf&Barthelemy, 2014). Examples include the medieval street layouts in European cities like London and Rome.

In addition to their unconventional structure, irregular networks epitomize the historical narrative of urban evolution. Their emergence often reflects an interplay of dynamic forces, including organic growth, historical legacies, and topographical limitations. Despite posing navigation difficulties, these networks exude a distinct charm, encapsulating a tapestry of cultural influences and diverse architectural legacies (Louf&Barthelemy, 2014). Noteworthy instances span the intricate paths of ancient Asian market towns and the serpentine alleys of North African medinas, each offering a mosaic of spatial intricacies akin to their European counterparts.

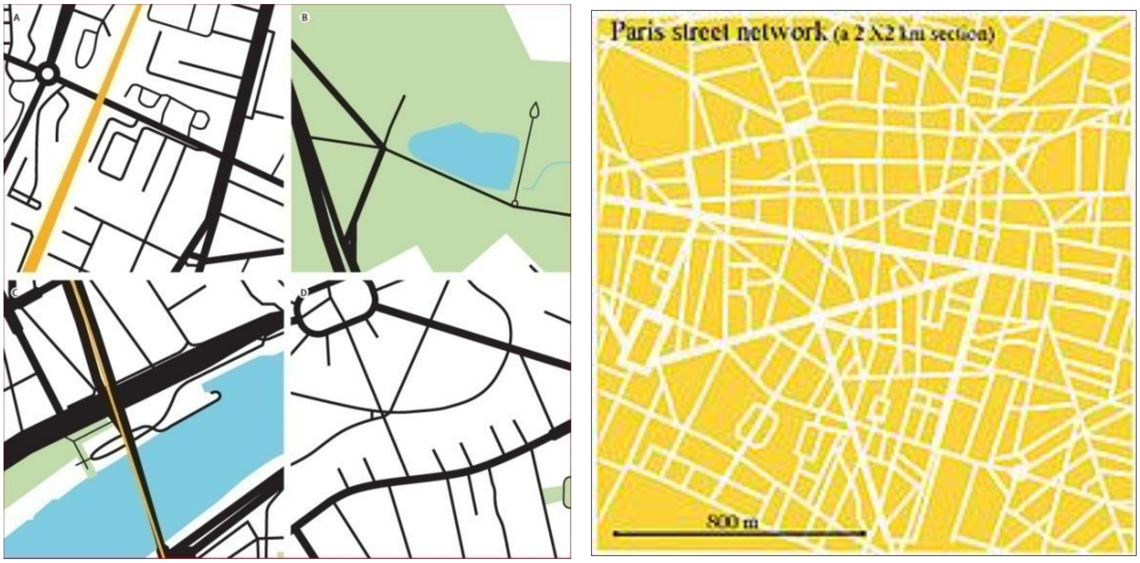


Figure 13 Irregular Street Networks. Source: (Google.2022)

5. Environmental Implications of Street Network Designs

Street network designs play a pivotal role in shaping the environmental footprint of urban areas, encompassing multifaceted impacts on air quality, energy consumption, and the overall ecological balance. Compact street networks characterized by higher connectivity foster walkability and support alternative transportation modes, diminishing reliance on fossil fuel-dependent vehicles and consequently curbing carbon emissions (Marshall, 2004). The promotion of pedestrian-friendly environments encourages active transportation, leading to improved public health outcomes and reduced greenhouse gas emissions.

Conversely, sprawling street designs typified by low connectivity and dependence on automobiles contribute significantly to increased vehicular traffic and extended commuting distances (Ewing &Cervero, 2010). This urban layout exacerbates pollution levels, including particulate matter and nitrogen oxides, thereby deteriorating air quality and escalating energy consumption. The extensive reliance on cars not only leads to environmental degradation but also amplifies the challenges related to traffic congestion and associated socio-environmental problems, including noise pollution and traffic accidents.

The impact of street network designs extends beyond transportation-related concerns to encompass stormwater management and urban heat island effects. Incorporating green infrastructure elements within street layouts offers a viable solution to mitigate environmental challenges. Features such as permeable pavements, green roofs, and strategically planted street trees play a pivotal role in managing stormwater runoff, reducing the strain on drainage systems, and preventing flooding incidents (Ahern, 2007). Furthermore, green spaces and vegetation help counteract the urban heat island effect by providing shade, decreasing surface temperatures, and enhancing evaporative cooling, thereby contributing to more comfortable and sustainable urban microclimates.

Integrating nature-based solutions into street network designs not only aids in environmental preservation but also fosters a more resilient and adaptable urban infrastructure. Furthermore, such initiatives align with broader sustainability goals, promoting biodiversity, improving air and water quality, and enhancing the overall well-being of urban dwellers.

6. Social and Economic Influences of Street Network Layouts

Street network layouts exert profound influences on social dynamics and economic activities within urban settings. Grid-like networks, commonly found in many historic cities, often facilitate social connectivity and interactions among residents by providing direct and multiple pathways for movement (Loukaitou-Sideris & Banerjee, 1998). These well-connected networks tend to foster a sense of community and social cohesion, encouraging pedestrian activities and public gatherings. However, street designs featuring cul-de-sacs or disconnected, winding roads, particularly prevalent in suburban areas, can limit social interactions by creating isolated pockets and reducing walkability (Appleyard, 1981). Such layouts may hinder community engagement and the formation of vibrant public spaces.

From an economic standpoint, street network layouts play a pivotal role in influencing land values and commercial vitality. Well-connected networks with higher accessibility tend to attract businesses, encouraging economic activity and bolstering property values (Bajic, 2016). On the contrary, fragmented or poorly connected street designs may hinder economic growth by impeding access to markets, reducing foot traffic for businesses, and limiting visibility. The spatial arrangement and connectivity of streets can significantly impact retail activity, influencing consumer behavior and economic development trajectories within urban areas (Pagliara et al., 2015).

7. Influence of Street Networks on Urban Mobility

The configuration of street networks directly affects the ease and efficiency of urban mobility. Well-connected networks, such as grids or hierarchical systems, often facilitate smoother traffic flow, shorter travel distances, and multiple route options (Hillier, 1996). These networks reduce travel times, enabling faster and more direct movement between destinations, thereby enhancing urban mobility.Street networks influence the choice of transportation modes available to urban dwellers. Networks with pedestrian-friendly infrastructure, dedicated bike lanes, and efficient public transit routes encourage alternative modes of transport, reducing reliance on private vehicles (Newman &Kenworthy, 1999). Improved accessibility due to well-planned networks enhances multimodal transportation options, providing greater convenience and flexibility for commuters.

Challenges to urban mobility arise from street networks characterized by congestion, bottlenecks, and inefficient road designs. Urban planning strategies focusing on compact city design, mixed land-use developments, and integrated transport systems aim to alleviate congestion and enhance mobility (Ewing &Cervero, 2010).Promoting sustainable transport modes is pivotal in improving urban mobility. Strategies emphasizing walkability, cycling infrastructure, and efficient public transit networks reduce reliance on cars, decrease traffic congestion, and mitigate environmental impacts (Banister, 2008). These approaches aim to create more livable and environmentally friendly urban environments.Advancements in technology play a crucial role in revolutionizing urban mobility. Integration of smart mobility solutions, including intelligent traffic management systems, real-time navigation apps, and autonomous vehicles, seeks to optimize traffic flow, reduce travel times, and enhance overall urban mobility (Caragliu et al., 2011).

Future street network designs are expected to integrate innovative concepts like shared spaces, complete streets, and pedestrian-oriented environments. Such designs prioritize human-centric approaches, aiming to create safer, more accessible, and inviting streets that cater to diverse transportation needs (Jacobs, 1961).

8. Street networks and spatial impacts

The intricate layout and structure of street networks wield a profound influence on the spatial configuration and dynamics of urban areas. Streets not only serve as conduits for movement but also shape the spatial organization, accessibility, and functionality of cities (Hillier, 1996).

Street networks impact urban spatial patterns by defining the distribution of land uses, determining the accessibility of different areas, and influencing the flow of activities within the city. The design of street layouts, whether grid-like, hierarchical, or organic, dictates the ease of movement and connectivity between various parts of the city (Porta &Crucitti, 2004). For instance, grid-based networks often provide greater accessibility and connectivity compared to irregular, non-grid layouts, fostering a more integrated and accessible urban fabric.

Moreover, the spatial arrangement of streets affects land use patterns and urban development. The design and density of street networks influence the concentration or dispersion of commercial, residential, and recreational zones within cities (Barthelemy, 2011). This spatial organization shapes the character and functionality of different urban areas, impacting economic activities, social interactions, and overall livability.

Additionally, street networks play a pivotal role in shaping the form and structure of public spaces. The presence of well-connected, pedestrian-friendly streets fosters vibrant public realms, encouraging social interactions, leisure activities, and community engagement (Jacobs, 1961). Conversely, poorly designed or inaccessible streets may lead to fragmented spaces, hindering social cohesion and the creation of active and inclusive public domains.

Understanding the spatial impacts of street networks is crucial for urban planners and policymakers to design more efficient, equitable, and livable cities. By recognizing how street layouts influence spatial configurations, planners can strategize to create well-connected, accessible, and socially cohesive urban environments.

9. Assessing Street Network Characteristics

9.1 Street Network Density

Assessing street network density involves analyzing the number of streets within a given area or the ratio of street length to land area. Higher densities often indicate better accessibility and shorter travel distances. Metrics such as block sizes, street lengths, and the presence of intersections help gauge the density of a street network (Porta &Crucitti, 2004). Evaluating density assists in understanding the distribution of streets and their impact on connectivity.

9.2 Coverage and Connectivity

Coverage and connectivity metrics evaluate how well the street network spans and connects different parts of the urban area. Connectivity indices, like the alpha and gamma indices, measure the network's interconnectedness, identifying how easily one can move between locations (Crucitti et al., 2006). Analyzing coverage identifies areas with inadequate access to the street network, helping planners target regions that need improved connectivity.

9.3 Identifying Infrastructure Needs

Evaluating street networks assists in identifying areas lacking adequate infrastructure. This assessment considers factors such as underserved neighborhoods, regions with poor street connectivity, or areas prone to traffic congestion. Geographic Information Systems (GIS) and spatial mapping tools aid in visualizing these deficiencies, enabling targeted interventions (Barthelemy, 2011).Understanding population growth, land-use changes, and transportation demands aids in planning new infrastructure. Analyzing future projections allows planners to anticipate and accommodate evolving needs, guiding the expansion or modification of street networks to support increased urban development and changing travel patterns.

10. Planning Efficient Street Layouts and Hierarchies

Efficient street layouts prioritize connectivity, accessibility, and safety. Design considerations involve selecting appropriate street widths, pedestrian pathways, bike lanes, and green spaces to create a balanced and functional urban environment. Factors such as minimizing traffic bottlenecks, promoting walkability, and integrating sustainable infrastructure are vital in the planning process (Jacobs, 1961).Implementing a hierarchical street design organizes streets based on their function and traffic flow. This approach categorizes streets into primary arterials, secondary collectors, and local roads, streamlining traffic movement and ensuring efficient access to different areas within the city (Porta &Crucitti, 2004).Evaluating and planning street networks demand a comprehensive understanding of urban dynamics, transportation needs, and land-use patterns. By strategically assessing density, coverage, connectivity, and infrastructure deficiencies, urban planners can design efficient street layouts and hierarchies that enhance connectivity, accessibility, and overall livability within cities.

11. Shared street

Van Eldijk categorizes streets into four types: (a) streets only accessible to pedestrians and cyclists, (b) streets with a balanced use of vehicles, bicycles, and pedestrians, (c) streets and roads dominated by vehicle transport with pavements on both sides for pedestrians and bicycles, and (d) roads only accessible to vehicle transport. Figure 25 depicts how these four street profile categories are used in an examination of an Oslo neighborhood. According to studies, the balanced street type improves street life and kid safety. The findings support (Gehl & Mortensen, (2001) and Jane Jacobs, (1961) assumptions that pavements are vital for producing life on streets between buildings.

In practice, street profiles can be more complicated than van Eldijk's. One example is the late Hans Monderman's'shared space idea,' which promoted locations free of traffic laws in the early 1990s. His basic concept was self-organization of street users and ongoing space negotiation (van Nes, 2017). This should enhance awareness among many users, particularly those using diverse modalities. It combines the functional logic of van Eldijk's first type with the transit modalities of the second type to classify the shared space notion. Balanced streets are often fashioned by their surrounding buildings, with their doors facing the roadway. In contrast, vehicle-only roadways lack walkways and are often inaccessible to pedestrians.

Figure 14 Four distinct street profiles with functions.
Source : (Google, 2020).

Compared to a regular street, a shared street gives more freedom. When arranging markets, festivals, or other events, it is simple to transform it into a pedestrian area. The remainder of the time, it permits motor vehicles access but does not give them precedence.Converting a roadway into a shared street saves space when it is too small to offer pleasant walkways that meet accessibility standards. It is also a wonderful approach to make access to businesses and services easier for persons with limited mobility or who use a stroller. If the shared roadway is well-designed, it will most likely attract a large number of people and have a good influence on economic growth (van Nes, 2017)..

Shared streets or shared spaces are areas where pedestrians, bicycles, and motor vehicles coexist. The design of shared streets should imply that the most vulnerable users should take precedence over all others. In other words, in order to move around securely, a kid, old, or disabled pedestrian should benefit from the awareness of all other users. The "vulnerability scale" continues with able-bodied walkers, bicycles, and other active forms of transportation, motorized two-wheelers, vehicles, and trucks. A shared street is intended to slow traffic and promote driver attentiveness. Motor vehicle operating speeds on shared roadways are typically between 5 and 15 mph. As a result, design cues that signal a preference for motor vehicles and different modes are eliminated. Vertical curbs, traffic lights, pavement markings, and other traditional street components are among them.As a result of functional categorization, priority has been given to automobiles. Separating humans from automobiles has resulted in the separation of location and mobility. Marshall feels that the roadway should cater to more than just vehicles. As a result, there must be a change in street design to make them more pedestrian friendly.(Marshall, 2004)

Low-traffic residential streets, particularly in older cities, may feature small or crumbling sidewalks. Many of these roadways function as de facto shared areas, with children playing and pedestrians walking alongside cars. These roadways have the potential to be renovated and improved as shared streets, depending on their volume and position in the traffic network. Shared roadways may suit the needs of nearby inhabitants while also serving as a public place for recreation, socializing, and leisure.

Many communities have mostly residential or other low-intensity roadways with subpar or non-existent walkways and green infrastructure. People driving, riding, and strolling on these streets make them de facto shared areas. Street flooding and collapsing are typical occurrences. These streets are frequently renovated as shared areas, providing a significantly enhanced environment for walking, biking, and playing while also accommodating service, delivery, and very local motor vehicle access.

Figure 15 Shared street in Somerville and Auckland. Source:(Karndacharuk et al., 2014)

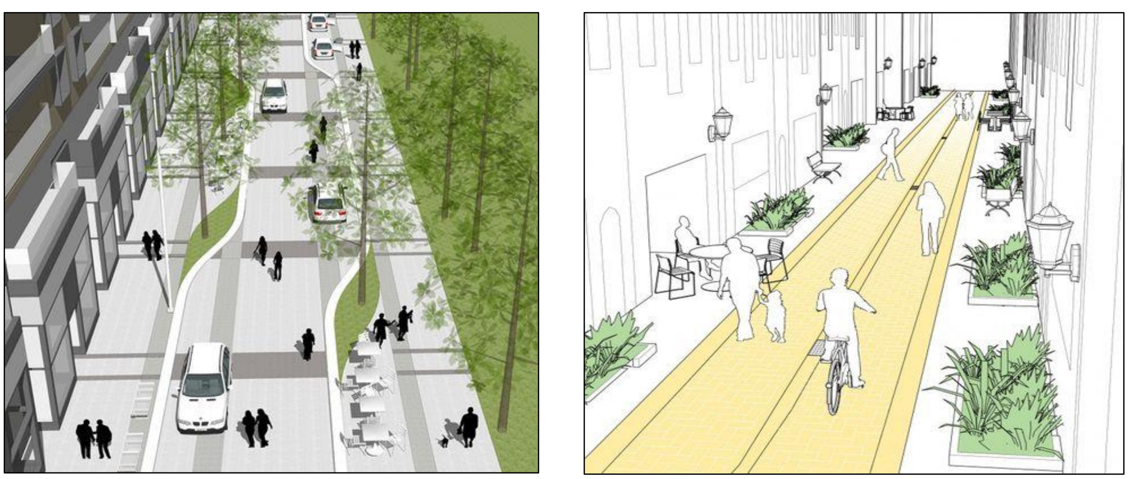


Figure 16 Auckland and West district master plan. Source:(Karndacharuk et al., 2014)

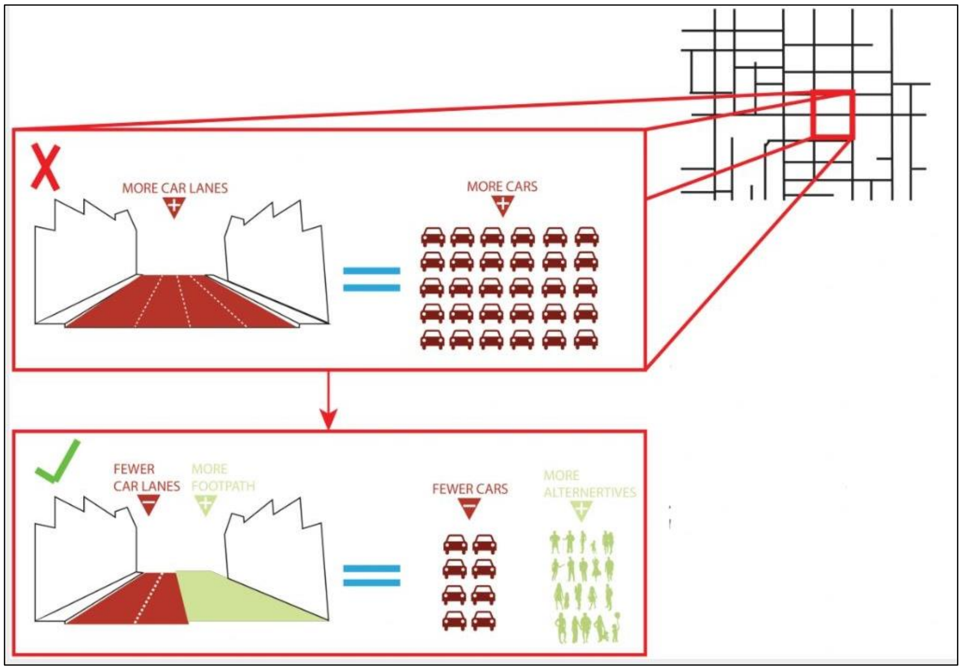


Figure 17 Marshall advocates for a shift in street design to make it more pedestrian friendly.
Source: (Marshall, 2004)

12. Conclusion

In this chapter we have shown that the issue of traffic in the city has aroused a great deal of interest, and has given rise to many recommendations by urban theorists and practitioners. These have been grouped together in the third paradigm. However, there are authors who are quoted in other paradigms who indirectly refer to the issue of traffic. For example, the Italian architect Vincentius Andrea Palladio argues that straight roads relieve the walker. He thus raises the question of the user's comfort when travelling. For his part, Abbé Laugier asserts that repetitive road networks such as those in grids are a source of distraction for individuals. He therefore refers to the ability of mobile users to find their way around. Finally, the philosopher of architecture Jane Jacobs, when she advocates making the road network a place of life, refers to the need to allow users to move on foot. She therefore indirectly addresses the issue of circulation. If we focus solely on the authors classified in the paradigm of the road network as a support for circulation, we can see that the issues they associate with the circulatory question are different. Some mention efficiency in travel, others their uniform distribution on the network, and other authors mention the convenience or safety offered to users during travel. The multiplicity of these issues indicates that in urban planning, travel is not only efficient: it can also be safe, convenient, uniformly distributed, etc. Thus, urban theorists and practitioners express their opinions on the different 'traffic conditions' they wish to offer users. These conditions concern aspects as varied as the comfort offered to the user, the congestion to which he is subjected by car, or the possibility offered to him to move on foot. Table.1 below summarizes (in chronological order) the main recommendations relating to the issue of circulation, taken from the texts and projects of the theoreticians and practitioners cited in this chapter. The majority of these authors are associated with the network paradigm as a support for circulation, but some of them have also been cited in relation to other paradigms. The first column corresponds either to an author or to a temporal and spatial context. The second column corresponds to the recommendations concerning traffic. The words in bold correspond to the traffic conditions mentioned.

The three design paradigms for road networks that we have proposed are the subject of work beyond the field of urban planning theorists and practitioners. The function of the road network as an image of the city is notably addressed in architectural and landscape studies, dealing with the perception of urban space. The function of the road network as a place to live is addressed by geographers and sociologists in their work on public space (Fleury, 2004)**.**For its part, the function of the road network as a traffic support is the subject of great interest in several disciplines (geography, urban planning and development, transport engineering, sociology, to name but a few). Indeed, since the 1920s, practitioners and researchers have made the issue of circulation their speciality, forging theories, methods and materials that have made this issue a scientific field in its own right. Considering this, how can we position urban theorists and practitioners within the scientific field of traffic studies? Where can their contribution be situated? What is the difference between the consideration of traffic in urban planning, and its consideration by the various scientific disciplines mentioned above? We explore these questions in the next chapter.

CHAPTER THREE

BUILT ENVIRONMENT DESIGN AND TRAVEL BEHAVIOR

1. Introduction

The links between the built environment and travel behavior are often investigated using travel behavior theory, which is based on economic theory. In assessments, design elements such as street networks and mixed uses are interpreted as differences in distance and time consumption. Reduced distance may result in shorter trips and consequently a larger proportion of pedestrians and bicycles, according to the notion. However, decreases in distance might result in more and longer trips. Both of these processes are active, according to the literature. Several disciplines contribute to a more nuanced understanding of the built environment's links with behavior. The constructed environment is classified into physical, spatial, esthetic, and functional characteristics, which are employed in professional communications. However, this idea provides little explanation for behavior. An interdisciplinary field combining built environment theory and behavior theory that seeks to understand the individual's perception of the environment, as well as their assessments of the environment and behavior. Social categories are also used to conceptualize the built environment. A typical divide is between public and private space, depending on whether the place is accessible to everybody or only a private group. Sustainable urban mobility necessitates well-informed neighborhood planning. Despite several research in the sector, there is limited evidence on the linkages between design features, urban quality, and behavior. In this setting, little is known about inhabitants' perceptions of design and urban quality.

The goal of this chapter is to provide a conceptual framework for the relationships between urban design and behavior that may also serve as the foundation for empirical research. A single field or theory cannot describe the complex reality encapsulated in the concerns about the relevance of urban design for travel behavior. The literature initially showed that it is appropriate to emphasize correlations at an individual level in order to find pathways between design and behavior. Several fields help to elucidate processes at the individual level. This literature study investigates the theoretical and empirical contributions of several disciplines to provide light on the linkages between the built environment and travel, as well as how residential choice influences these relationships. It outlines contributions based on economic theory, configurational theory, social psychology, and environmental psychology.In this chapter, also, there is a focus on the study of urban morphologyat various times and from varied viewpoints resulting in a broad variety of methodological outputs, which may be observed in numerous schools of thought; British, Italian, and French. Furthermore, the schools of thought will be analyzed and the relevant terms and expressions will be explained. As a result, an adaptive comparative approach will find their similarities and differences.

2. The role of urban design in making a livable environment

Transportation, traffic, and environmental concerns have all had a significant influence on urban growth and neighborhood design principles. The goal of facilitating new lifestyles, including the nature of daily travel patterns and preferences for residential quality, is shared by earlier and current ideals and principles. Although the new urban design principles are similarly influenced by the neighborhood unit, certain distinctions may be found in drawing comparisons between modernist ideals and new urban ideals that may have implications for assessments of design's impacts on behavior. These two design goals are tied to several assumptions about people's behavior patterns. The features of the neighborhood unit concepts were governed by modernist theory, which argues that people have a demand for access to specific services, schools, and other activities and that the frequency of travel to these locations is predictable. The street arrangement was created to link these planned activities to houses. The grid arrangement was criticized for causing needlessly lengthy travels.

New urban suggestions include a critique of previous theories and practices. They are influenced by the modernists' assumption that social life revolves increasingly on commercial activities such as coffee shops, restaurants, and shopping. As a result, commercial firms and variations in activity over time receive greater attention than social organizations. According to this viewpoint, the occupants' activity patterns are more erratic and unpredictable. Grid street networks provide widespread access that is tailored to this activity pattern.While modernist architectural principles were backed by the contemporaneous conviction that strong state planning was required to provide citizens with a happy existence, new urban ideals have evolved during a period of market deregulation. Although it is not frequently stated explicitly, the ideal mix of activities in the new designs is supposed to be established by supply and demand in a market-controlled process.

The assumptions about inhabitants' desires for residential quality change between the ideals. Individuals want seclusion from other urban activities, according to the modernist viewpoint, which is connected to the concept of division of functions. Separation of dwelling kinds was one of the aims. The typical family with two adults and children was envisioned as the ideal of the neighborhood unit. Housewives were considered to be married women. A lot of thought was given to children and their desire for a child-friendly environment. Residents are supposed to choose an urban lifestyle in a bustling public area in the new ideals. These ideas emphasize the value of social diversity and a variety of housing forms. In contrast to modernists, they primarily focus on the individual and the adult.Parallel to shifting planning principles, the conventional approach on transportation and traffic policy has moved from "predict and deliver" to "manage" transportation and traffic growth. The design ideas are provided as a contribution to new goals of minimizing automobile reliance and use. This calls for more research into how community design might minimize automobile usage while yet contributing to beautiful areas.

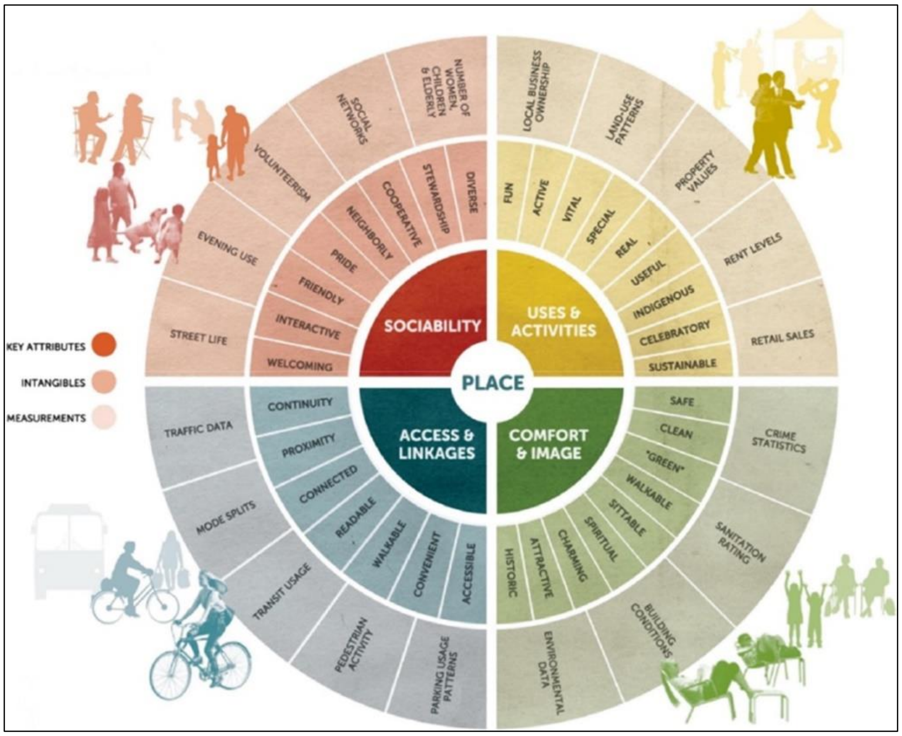


Figure 18 Shows the livable place diagram developed by PPS,
The pedestrianization scheme is an important indicator of a good quality space or street, but must include multi-functionality, such as socialization and community interaction, to achieve livability.Source:(Yassin, 2019)

Figure 19 Left: CopenhagenThe best livable cities in 2016.
source (*The 10 Best Cities to Live In (2016) - Metropolis*, n.d.). Right: Five principles of Livable Cities.
Source (Respati et al., 2020).

3. Built environment and behavior theories and empiricism

3.1 Researches based on economic theory

Traditional travel behavior theory is based on economic theory and is commonly used to analyze links between urban planning and travel. In economic theory, activities are governed by desires within a framework of finite resources (Nicholson & Snyder, 2012). According to travel behavior theory, travel occurs as a result of derived demand, which indicates that the desire for activities leads to travel. Attractions are places where people go to do things. It costs money to travel to them. The individual is presumed to weigh the cost and usefulness of a journey connected with the variousmeans of transportation available. The constructed environment is regarded as a set of options that provide benefits to the individual in this notion.From this vantage point, density and mixed-use provide additional options near to homes. This method is also interested in the psychological processes underpinning travel pattern decisions, as well as the impact of subjective distance and choices. The initial notion was eventually expanded to encompass non-destination journeys, such as automobile drives to get away from home and walks to obtain some fresh air. Some of these outings are made for no other reason than that the folks involved love driving a car or going for a stroll. If a trip has a positive value, it might help to offset some of the experience cost. (S. L. Smith et al., 2002) analyzed pedestrian movements in Austin, Texas, and proposes the idea that walks, more than other journeys, do not have a purpose.

The time spent on trips is a significant component of the expense. According to travel behavior theory, urban design influences time expenses by increasing the distance between destinations. This includes variances in distance, which can be caused by changes in the design of street networks. The cost of a journey includes the impact of design features on the ease with which various modes of transportation may be used, such as access to parking, walkways, and bicycle lanes.

A prevalent assumption in travel behavior research is that shorter travel distances or lower time costs result in shorter trips and less overall travel. This assumes that there is a specific person and household activity pattern, such as work, shopping, child care, and recreation, and that the individual seeks to meet the desired activity pattern at the lowest feasible travel cost. Economic demand theory (Crane, 2000) backs up critics of this strategy. According to the hypothesis, lowering the price of items increases demand for their consumption. An application of demand theory to activity and travel behavior leads to the premise that lower travel costs lead to more activity, more trips, and longer trip durations. A shorter distance can affect both the absolute and relative trip costs of any method of transportation. According to the hypothesis, if a shorter distance is sufficiently short to give incentives to walk, it might result in fewer automobile journeys. A shorter distance, which mostly impacts motorists, may result in more automobile journeys. Quicker distances between locations, as well as roadway networks that allow shorter routes, can result in both less and more travel frequency among motorists (Crane, 2000).

Neighborhood studies are frequently carried out by distinguishing urban kinds and drawing comparisons in terms of travel behavior. It is usual in these research to distinguish between classic urban and suburban kinds. Traditional urban styles are distinguished by larger densities, mixed-use developments, street grid designs, and conditions that promote walking, biking, and public transportation.In these studies, suburban communities are distinguished by functional isolation, cul-de-sac networks, and automobile-oriented architecture. According to several research, traditional neighborhoods are associated with fewer automobile trips and lower overall travel lengths (Bagley & Mokhtarian, 2002). Various methodologies are used in studies of the links between design and travel. Some research, known as aggregate studies, employ data on average travel or gas consumption in neighborhoods, towns, and regions to explore connections, primarily between population density and travel. These studies have been chastised for failing to distinguish between the importance of urban design and socioeconomic issues. Another type of automobile owner. After studying disaggregate studies on urban design and travel, it was found that Disaggregate studies employ data at the person or household level to investigate connections between urban design elements and travel behavior. These studies account for the importance of socioeconomic factors such as money and education.

• Trip frequency tends to be largely determined by socioeconomic aspects of travelers and secondarily by elements of the built environment.

• Trip lengths are largely determined by built-environment features and, secondarily, by socioeconomic considerations.

• Modal selection is influenced by both socioeconomic variables and built-environmental elements, but perhaps more so by socioeconomic reasons.

• When compared to other metrics of travel, the number of vehicle kilometers shows a far greater significant connection with elements of the built environment.

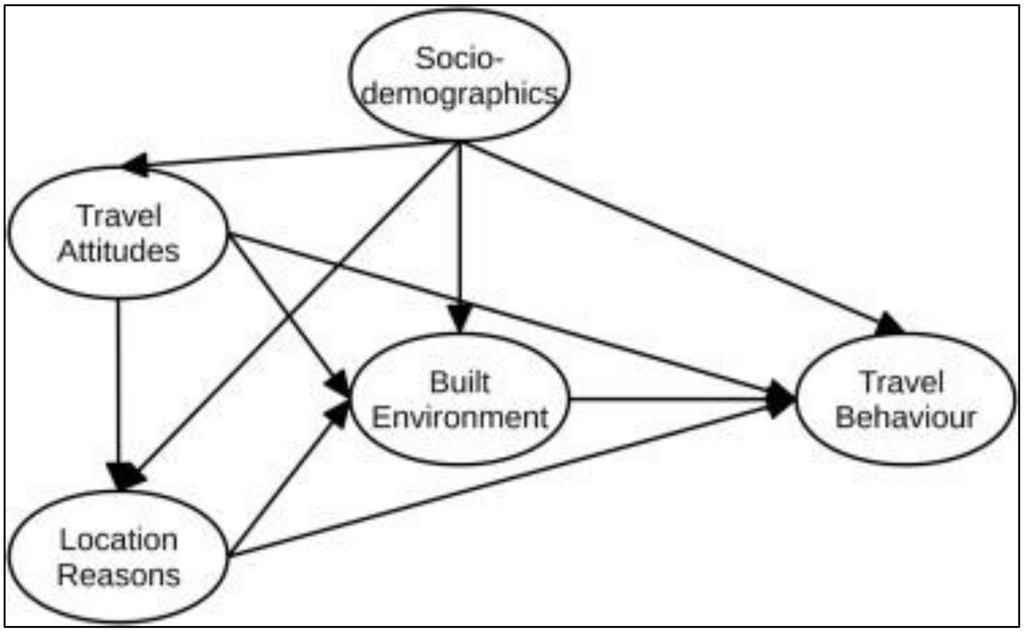


Figure 20 Model to estimates the effect of the built environment on travel behavior by controlling for both mode attitudes and travel-related location reasons. Source: (Faber et al., 2021)

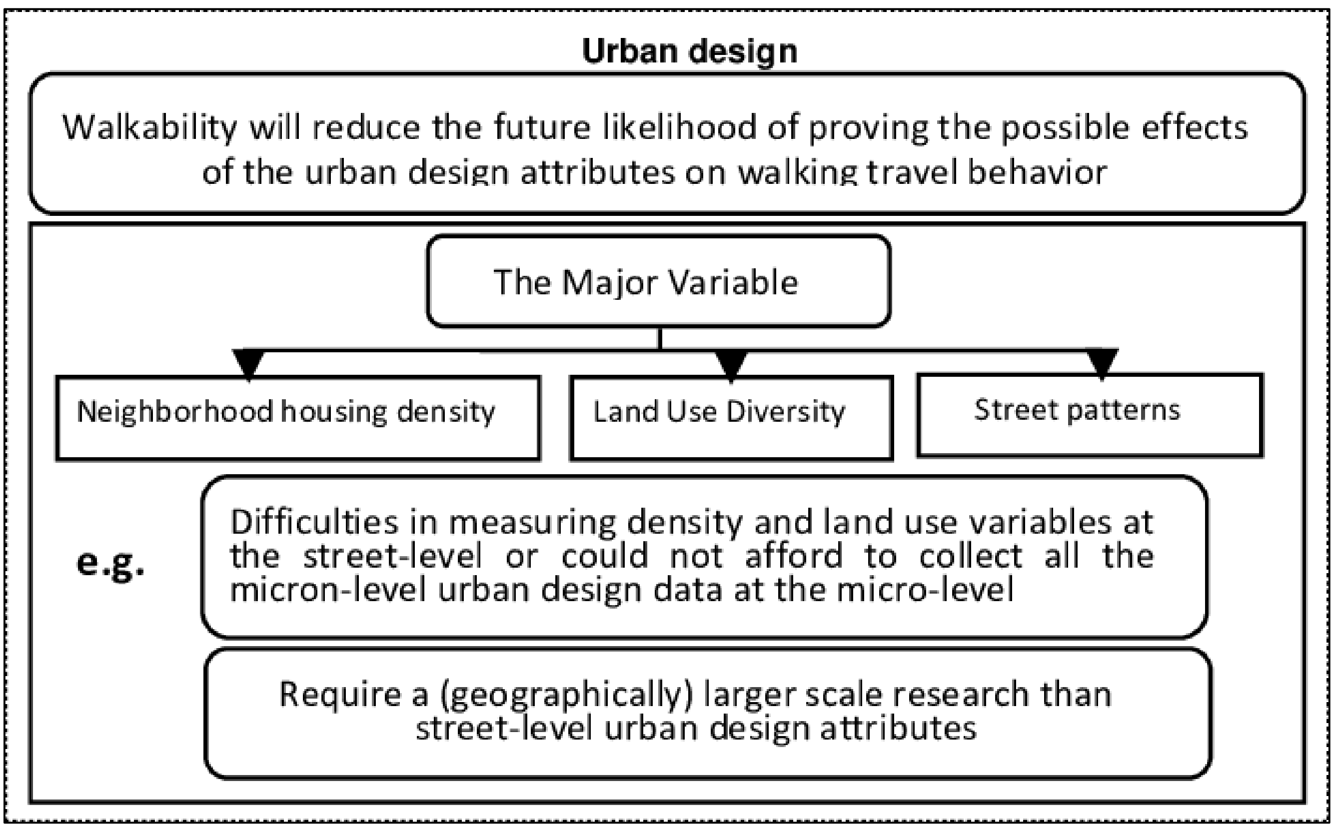


Figure 21 Major walkability variables in urban design.
Source: (Smith et al., 2013)

3.2 Normative aesthetic studies of built environment

A large body of literature has published metric analyses of urban planning in an attempt to characterize the aesthetic aspects of the urban environment during the last quarter century. This practice dates back to Camillo Sitte's work (Musterd & Salet, 2003) , whose book City Planning first published in 1889, presented the doctrine of a visually ordered city. Sitte developed several layouts of urban squares and plazas at the same scale for comparative purposes to illustrate his arguments. Sitte’s drawings became famous in the English-speaking world when Hegemann and Peets included them in their book "Civic Art: The American Vitruvius" (Akcura, 1971). Later, Paul Zucker, who helped develop Sitte's ideas in his book ‘Town and Square’ (Zucker, 1960), also used plans and maps as important documents in his study. Aesthetic studies of urban design based on maps and plans have continued into the 21st century (Neill, 1997; Major, 2018). The majority of aesthetic studies of urban layouts are normative in the sense that they do not strive to explain urban layouts. They debate how cities should be developed. They frequently aid in the direction of precedent-based urban design and city planning by providing a framework of reference based on metric geometry to compare one city to another focusing on individual urban elements such as urban plazas, squares, or spaces and streets (Musterd & Salet, 2003 ; Akcura, 1971 ; White & Crimmins, 1976 ; Stone, 2001; Al-Attar, 2018).

Some of these studies look at areas broader than individual urban features in order to better explain the environment in which particular elements exist. However, because of the small number o(Stone, 2001)f towns studied, these studies are analytically weak (King, 2011). Others, who analyze considerably broader study regions, include an even fewer number of cities and focus on the compositional spatial links between physical and abstract realities (Arbury, 2005).

The professional perspective is also used in most normative assessments of the aesthetic aspects of urban layouts. This is not unusual considering that architectural treatises have long included remarks about excellent structures and good settings, as well as the ideas necessary to develop them. From Vitruvius (Brayley et al., 1850) 2000 years ago to today's architects and urban designers, all have been concerned with the consequences of their work—particularly as seen by themselves and their detractors. Finally, most normative aesthetics studies focus solely on cities in the industrialized Western world, owing to the fact that architectural traditions in the other half of the globe are not comparable to those in the Western world. As a result, more than a century after Sitte's work was published, normative studies of the aesthetic aspects of urban form might still develop in a variety of ways.

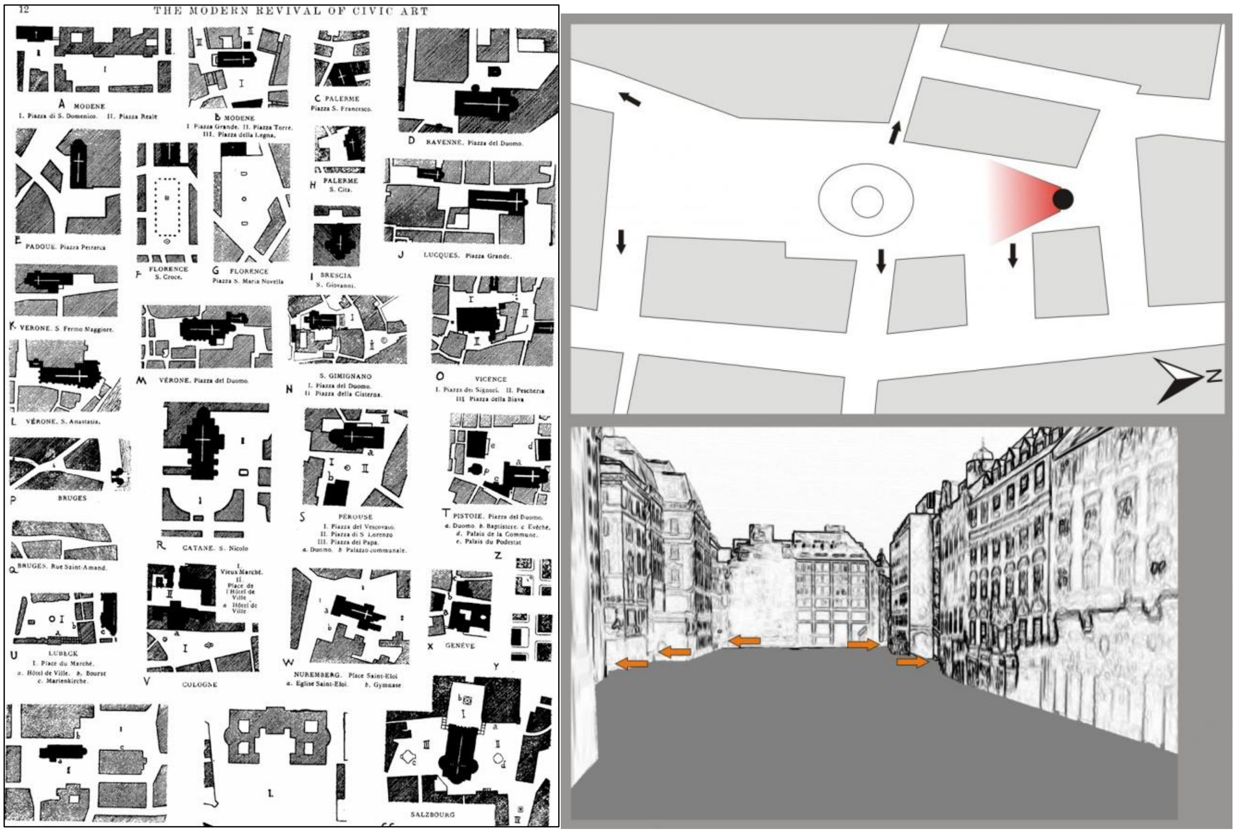


Figure 22 Left The modern revival of civic art.Right, the New Market, Vienna.
Source:(Sitte, 1889)

Sitte lays the foundations for the morphological analysis of the urban composition of squares. Referring to the positions of ancient masters such as Aristotle, Sitte emphasises that "the principles of the art of city building can be summarised in the fact that a city must offer its inhabitants both security and happiness". This can only be achieved if the construction of cities goes beyond the technical issue to fully integrate the 'artistic', i.e. aesthetic, component. Although, C. Sitte's approach is exemplary of a certain way of thinking of the city as being constructed from the assembly of materials(*Approfondissement Théorique : Les Fondements Esthétiques de La Composition d'une Place (C. Sitte). | Espaces Publics Places*, n.d.). However, Sitte's study focused on specific conditions within the city, often without addressing the larger framework that constituted their creation. It largely remained an "archaeological" study of fragments, as the cities and plazas in question were artefacts glazed in their current form and were not subject for change. His study omitted another dimension, the temporal dimension of a city.

The work of C. Sitte was initially criticised for its backward-looking aspects. However, it inspired numerous works on the extension of cities (particularly in Germany and Austria). Above all, they had a decisive influence on the development of English garden cities and Anglo-Saxon culturalist urbanism: the return to medieval aesthetics and the human and social dimension of the city were directly inspired by C. Sitte. Others decried C. Sitte's work, such as Le Corbusier, who accused him of having founded a new "religion of the donkey way", thus highlighting the incarnation of the most backward-looking pastist.

3.3Environmental psychology approach of the built environment

Environmental psychology research approaches the built environment in empirical character, in contrast to normative aesthetic studies. Environmental psychologists use social science methods and theories to answer questions about human psychology in relation to the large-scale everyday physical environment, whereas traditional psychologists ignored the physical environment and test variables under unrealistic lab-like conditions with little relevance to people's everyday lives. Environmental psychologists are generally interested in all perceptual, cognitive, and behavioral aspects of psychological significance in everyday life because they influence how individuals utilize, notice, interpret, and recall their surroundings. This is important for architects, urban designers, and city planners since they need to know about the potential consequences of their designs on users, as well as the areas of user consensus.

Since Kevin Lynch's initial study of ordinary urban residents' spatial and landscape awareness(Lynch, 1964)and Jane Jacobs' arguments for "urban liveliness" based on her observations of city life(Jacobs, 1961), there has been a significant increase in interest in measuring environmental features of psychological significance. Lynch analyzes urban people’s perceptions of the city using verbal interviews and sketch maps, as well as trained field observers' observations of the city's visual structure, in his book The Image of the City (Lynch, 1964). He observes that, in the midst of boundless visual information, urban dwellers develop their impressions of the city using only a subset of the city's streets and land uses and structures.

The imageability of the city, according to Lynch (Lynch, 1964), does not need to be fixed, restricted, exact, unified, or regularly arranged, though it may have these qualities at times. The imageability of the city, like any excellent framework, offers the viewer with a readable framework providing multiple choices and opportunities for an increased comprehension of the city. Lynch's explanation of a city's imageability based on its five characteristics, however, has limits. These components are defined by him in ways that are neither physical nor geographical. He effortlessly combines objective formal qualities of shape and space with experience as conditioned by personal and societal values. Lynch's study also ignores people's perceptions of various other environmental elements that are not connected to wayfinding or imageability but might be essential for other types of activities and behaviors. Finally, Lynch's analysis never takes into account the structural relationships between the aspects of the city's image that he anticipates would be significant.

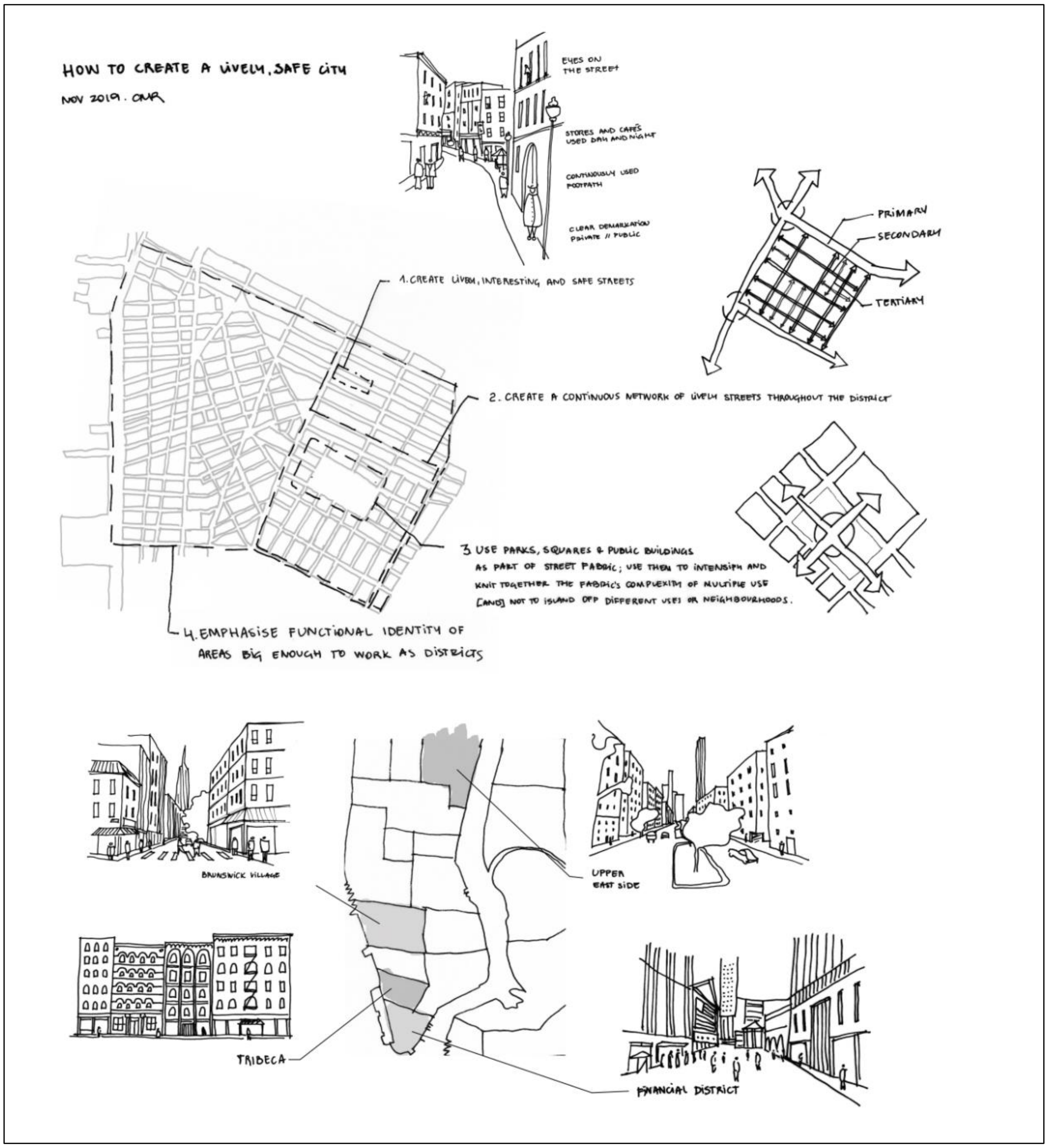


Figure 23 Jacobs outlines four factors that define a vibrant city. Source: (Google, 2022)

While Lynch (Lynch, 1964)is keen to use research information to enhance urban design and city planning, Jacobs argues against all rationalist, modernist planning techniques in her book The Death and Life of Great American Cities (Jacobs, 1961), pointing out that active cities cannot be formed from scratch. These cities' sophisticated organization emerges organically throughout time. Jacobs identifies four distinct preconditions for urban liveliness based on her field observations. These include "districts" that must have "a dense concentration of people" to improve street safety through spontaneous protection supplied by pedestrians and those viewing the pedestrians from buildings, and "districts" that must have "a dense concentration of people" to promote street safety. serve more than one primary function to ensure the presence of people using the same common facilities at different times, "blocks" short enough to increase path options between points of departure and destinations, and "buildings" of varying ages, accommodating different people and businesses with varying rent levels. Though it is evident that some of Jacobs' preconditions of liveliness are dependent on how the urban layout is designed, she leaves the work of developing specific definitions for these preconditions to others. Environmental psychologists have found many additional significant perceptual, cognitive, and behavioral characteristics of the environments since Lynch (Lynch, 1964; Jacobs, 1961), but only a handful have been clearly defined. Enclosure, permeability, spaciousness, openness, and mystery (Benedikt, 1979;Stamps III, 2003) diversity, complexity, and order (Kaplan & Kaplan, 1989; Stamps III, 2003); and affordances for physical activity(Smith et al., 2002) are among the well-defined ones that demonstrate some dependence on urban form. It is important to emphasize here for our purposes that the majority of these constructions are based only on user answers, and they do not include any direct assessments of the geometric features of the urban layout [for exceptions, see (Benedikt, 1979;Stamps III, 2003;Stamps III & Krishnan, 2006; Stamps III, 2004; Stamps III, 2010)

The "mental map," or "cognitive map," of the city, first mentioned in Lynch's imageability research (Lynch, 1964), has received the most attention in empirical studies of urban layouts and has the most basic geometric links. It is also a factor that connects cognitive science and psychology, as well as the subject of spatial cognition, to the study and science of cities. (Portugali & Stolk, 2016). The term systemic is used deliberately here to stress that human cognitive distortions of physical space are frequent and occur not as a result of a malfunction of the mind or brain, but because that is how the mind is designed to function.(Portugali & Stolk, 2016). Some cognitive distortions—biases and misunderstandings may be important for urban layout studies include: (1) Humans perception maps as more genuine than experience.; (2) They have diverse perspectives on large-scale geographic space and small-scale space.(Freundschuh & Egenhofer, 1997); (3) They seem to have little evidence.(Montello, 1992); (4) They used diverse spatial concepts. (Portugali, 2005;Tversky, 2005;Larkham, 2006)They examine different levels of detail in diverse sized areas. (Hirtle & Jonides, 1985); and (Vitor Oliveira &Pinho, 2006)and (Siksna, 2006)their view of space is tied closely to their perspective of time.(Hirtle & Jonides, 1985; Whitehand, 2001) their sense of distance is asymmetric and mathematically unspecific

(Hirtle & Jonides, 1985 ;Conzen, 1978)the hierarchical structuring of spatial knowledge influences their evaluation of spatial links and places.Stevens & Coupe(1978)their categorical biases worsen over time.(Uttal et al., 2010).

The aforementioned cognitive spatial distortions imply something fairly radical for spatial design and scientific fields, namely that metric geometry, which is used to represent actual physical space, may not be the only method to explain our experience of space. As a result, they offer up new avenues of exploration for scholars focusing on the link between geometry and spatial experience. They must now develop new geometric approaches and metrics to explain human spatial experience while taking their spatial biases and misconceptions into consideration. Some of these geometric methodologies and metrics are covered in the section on urban plan configuration studies. But first, a relatively lively tradition of morphological studies of urban layouts is presented, which employs metric geometric representations and measurements of urban layouts to characterize the impact of various physical, functional, and social processes on these layouts.

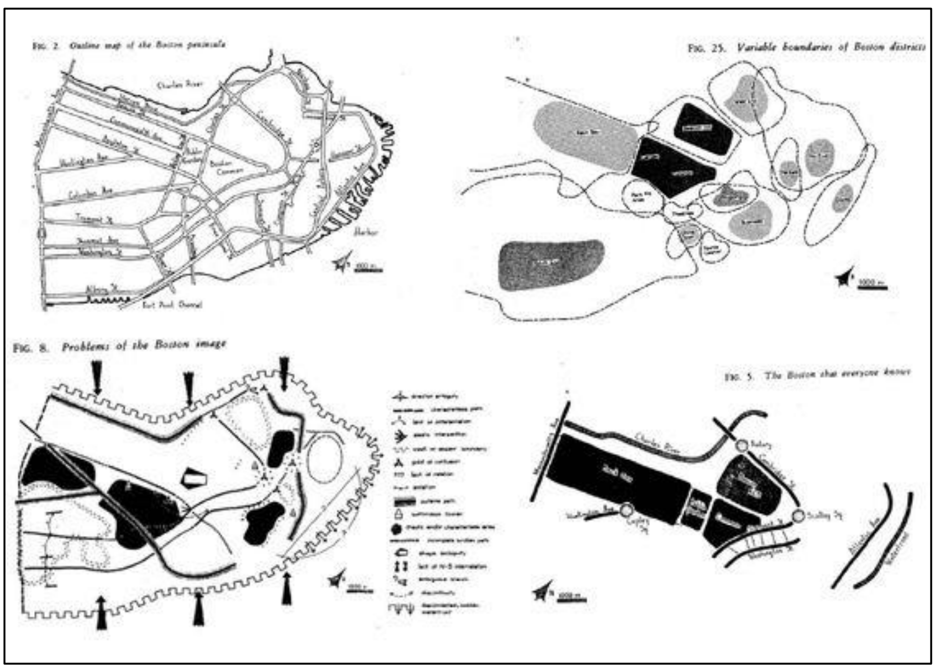


Figure 24 Kevin Lynch's analysis of »urban problems Boston City (Kevin Lynch (1960).
Source:(*Mental Map ; Kevin Lynch – Recherche Google*, n.d.)

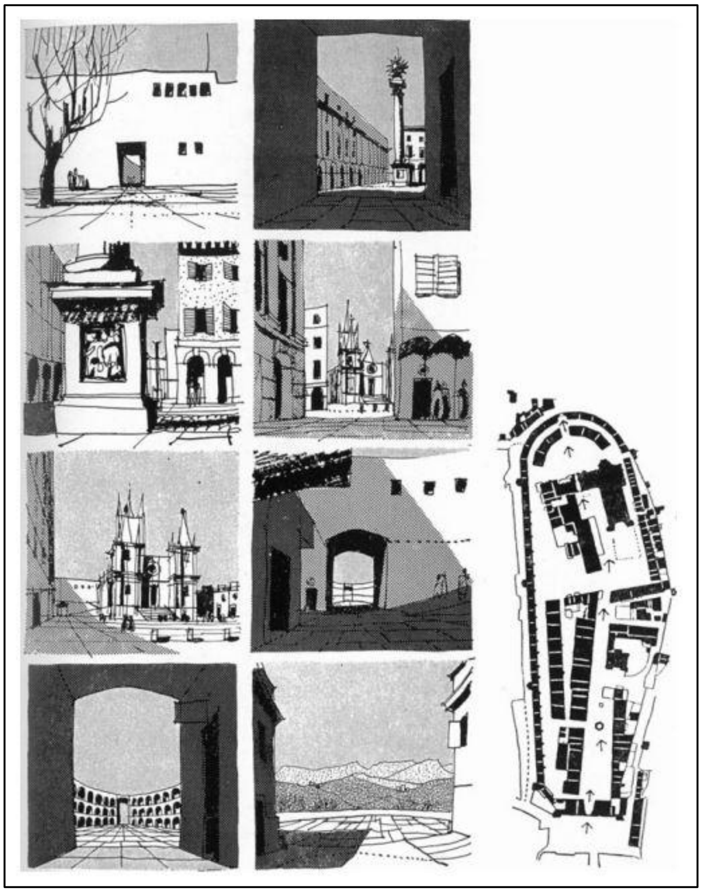


Figure 25 Serial vision of townscape,
Conzen's theory of plan analysis requires a full investigation of land use and building types to produce a complete interpretation of the townscape. Source: (Vítor Oliveira, 2016).

3.4 Social psychology approach and the built environment

Interest in social psychology is aimed toward how attitudes and behavior are created, that is, how attitudes are taught and transformed in response to environmental stimuli. This section investigates how social psychology theories can help to explain links between urban form and travel behavior.

Attitudes sparked interest since it was assumed that they might be used to predict behavior. There was also a desire to influence attitudes in order to modify conduct. An early observation was that opinions alone do not accurately predict conduct. Intentions, on the other hand, have been found to predict behavior.

An intention, according to the idea of reasoned action, is a consequence of attitude and subjective rules. The view of how other individuals significant to the decision-maker regard an activity, as well as the incentive for acknowledgment from these people, is referred to as a subjective norm (McDougall, 2015)

Ajzen (2005)extends the notion of reasoned action to fit circumstances with inadequate control in the theory of planned conduct. A primary element remains intention, but it is supplemented by three determinants in Ajzen (2005) theory. In addition to attitudes and subjective standards, perceived behavioral control is a factor. This component is concerned with one's own capacity to accomplish specific behaviors, such as riding a bicycle or driving a car. In his theory, Moore, (1979) shows no special interest in the constructed environment. However, behavioral control does not rule out physical, spatial, or other environmental elements. According to the notion, an individual's memory of bicycling, walking, or driving a car in various contexts of the built environment might contribute to the individual’s experience of behavioral control. A research in Gothenburg, Sweden, found that behavioral control is important for modal choice (McDougall, 2015). According to the findings, modal choice is mostly explained by characteristics such as convenience, lack of time, security, and freedom. As a result, these experience aspects can serve as explanatory variables in the relationship between design and behavior. The study also demonstrates that experienced behavioral control is unique to each individual. A motorist values the ease of driving a car far more than a biker. Similarly, a driver believes that a bicyclist is more likely to be involved in an accident than a biker does.

A research in this context, found that behavioral control is important for modal choice (Dergison, 2018). According to the findings, modal choice is mostly explained by characteristics such as convenience, lack of time, security, and freedom. As a result, these experience aspects can serve as explanatory variables in the relationship between design and behavior. The study also demonstrates that experienced behavioral control is unique to each individual. A motorist values the ease of driving a car far more than a biker. Similarly, a driver believes that a bicyclist is more likely to be involved in an accident than a biker does.

Psychology research has focused on affecting behavior. Several psychological processes are involved in modifying attitudes and behavior, according to(Moore, 1979)theory of cognitive dissonance implies that people are driven to preserve consistency between attitudes and experiences in their own conduct. When dissonance occurs, the individual is compelled to adjust his or her attitude or conduct, or to place less emphasis on the conflict. According to balance theory, people are driven to preserve a cognitive and emotional balance between their attitudes and relationships with others. According to the idea of social judgment, attitude shifts are determined by how individuals judge a persuasive attempt in connection to their pre-existing attitude structure.

Behavioral theory in cultural psychology focuses on influencing an individual's behavior, as a concentration on attitudes and beliefs may lead to the ignoring of other essential variables (Passini et al., 1998). According toSubiarto(2003) changes in knowledge or attitudes are neither essential nor sufficient for behavioral change. Under some situations, behavioral change is required before changing values, which is consistent with cognitive dissonance theory. The word 'antecendents' refers to earlier occurrences in the theory. The preceding events might be made up of components in the built environment that provide opportunities and constraints for activities. If this link is extended to urban policy, it indicates that regulating urban design to reduce automobile usage may be a prerequisite for altering values in relation to automobile use.

Social and cultural psychology theories can explain how the constructed environment influences an individual's views and behavior, as well as how these attitudes and behaviors propagate amongst individuals. According to Moore, (1979) explanatory model, the environment influences activity goals and travel patterns via behavioral control. The built environment has an indirect impact on people's behavior and attitudes, which social psychology theories can explain.

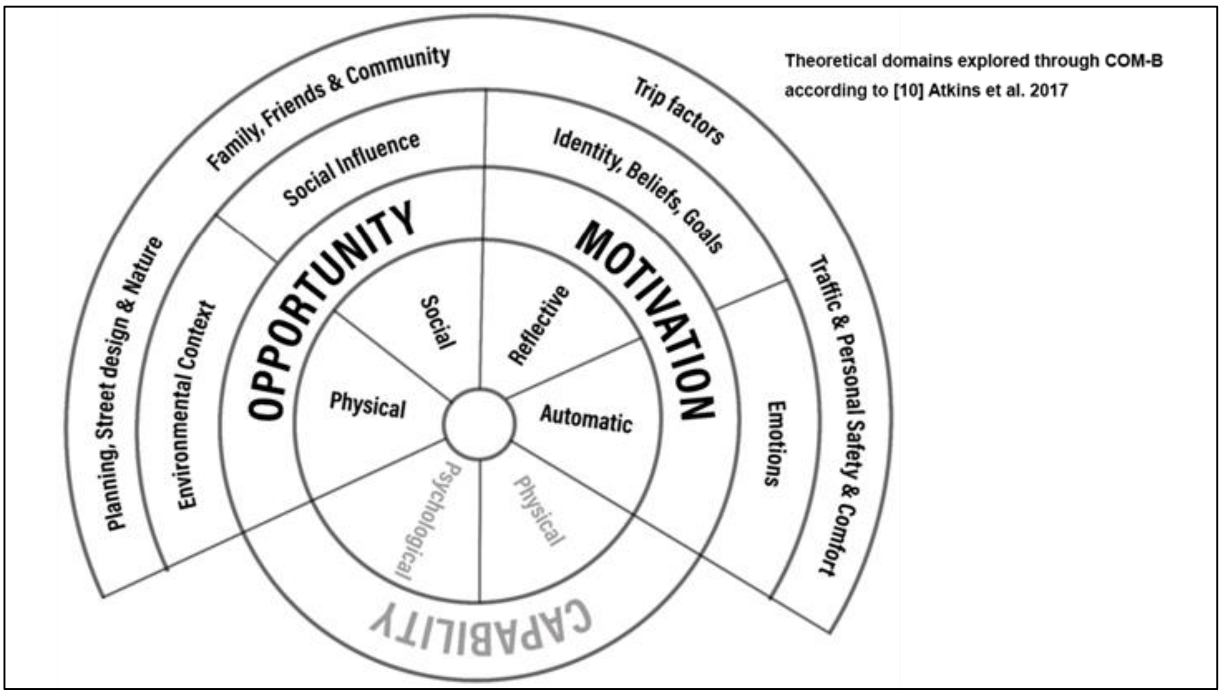


Figure 26 How behavioral science may be used to guide urban design to promote active travel. Source (*How Behaviour Science Could Inform Urban Design Interventions to Promote Active Travel - Sustrans.Org.Uk*, n.d.)

3.5 The urban morphology approach and the built environment

Since there are numerous definitions of urban morphology, there are several approaches to the concept of this term. Here are several examples:"morphology" derives from the words "morphe" (form) and "logie" (logic). The former implies that morphology is the logic of comprehending form. These studies have been carried out in a variety of sectors in order to emphasize the properties, structure, proportions, and modification of materials and their constituent constituents, and was later adopted in other fields such as biology(Oxford Dictionary, 1989). According to (Moudon, 1998), morphology is a branch of science that studies shape, form, outward structure, and manner of organization. This word is used in Biology to examine not only the form and structure of plants, animals, and microorganisms, but also the magnitude of shape, structure, and connection of their components. Despite the fact that studying the function of organisms and their components, which is based on their kinds and known as physiology, is the polar opposite of the former, their separation is contrived owing to a strong link between organism's functions and structures. In the following, we will lay out some definitions derived from different approaches and schools of thought:

• Urban morphology is a study that focuses on the concrete repercussions of social and economic conflicts, and so evaluates the method of intents and assumptions on which the formation and layout of cities is founded. Buildings, gardens, streets, parks, and sculptures are all important components of morphological analysis. Nonetheless, these features are gradually modified and altered throughout time (Moudon, 1998)

• Urban morphology is the systematic study of the form, shape, map, structure, and functions of cities' artificial fabric, as well as their genesis and evolution technique across time (Madanipour, 2013).

• The term "morphology" refers to "outlines, buildings, functions, streets, characteristics, and urban viewpoints" (Madanipour, 2013).

• Urban morphology is a word that refers to several sorts of studies that all focus on the physical shape of urban environments (Whitehand & Morton, 2006).

• Urban morphology is the study of the concept of form and urban space combination, which helps urban designers understand local patterns of development and change methods (Carmona, 2021).

3.5.1 Urban morphology study schools of thought

3.5.1.1 The Italian school of thought

In Italy, the discipline was strongly influenced by Saverio Muratori (1959) and his former student and assistant Gianfranco Caniggia (1963). In addition to works of a theoretical and methodological nature on the architectural and urban planning project, these two authors are known for having introduced the historiographical genre of the "city reading". With the conviction that reality is intelligible and not the result of pure linguistic conventions, Muratori (1959)encouraged his students at the Faculty of Architecture in Venice from the 1950s onwards to record the constructive and distributive structures of the buildings of entire city blocks and then to deduce retrospectively, from the current state, the successive phases of densification and restructuring until he obtained a representation of the first colonisation of the site.

This experimental and boldly hypothetical student work was published in a landmark book entitled *'Studi per una operate storia urbana di Venezia'*. Paolo Maretto, one of the students participating in this course, and future assistant to Caniggia (1963)at the University of Rome, updated this "reading of the city" in 1986 under the title '*La casa veneziana nella storia della città dalle origini all'ottocento'*(Zucker, 1960) The book opens with a valuable contribution by Gianfranco Caniggia entitled "*La casa e la città dei primi secoli"*(Caniggia, 1963), which includes a rigorous demonstration of the presence in Venice of a substratum of vast primitive enclosures of about 14 to 17 m. Caniggia (1963) refers to these as "*domus elementari*" (courtyard houses), which were later converted into complex urban blocks through successive densification of open spaces and differentiation/hierarchization of buildings. Caniggia (1963) refers to this process with the Italian term "*insulizzazione*" (literally "formation of an insula, an island") by analogy with the formation of the urban collective housing building in Roman times through horizontal densification and elevation of an ancient single-family domus. In the same year, 1986, Caniggia , together with (Maffei , Paolo Marconi, Adelaide Regazzoni, Francesca Sartogo and Paolo Maretto as consultant for the urban history of Venice, took part in the competition organised by the '*Istituto autonomo per le case popolari'* (IACP) for the urban redevelopment of the Campo di Marte district on the island of Giudecca (Zucker, 1960). This competition project constitutes, in a way, the operative part of the morphogenetic analyses mentioned above. The Muratorian school has always claimed that the study of the formation and transformation of cities over time (in other words, the understanding of their morphogenesis) was an essential prerequisite for acting as closely as possible to the tendency of things and situations (notion of storia operante, of operative history), (*Morphologie Urbaine — Wikipédia*, n.d.). In the Muratorian and Caniggian methodology of the project, the moments of "reading" and "designing" architecture and town planning are closely linked. Shortly after Muratori left the Faculty of Architecture in Venice to honour his appointment at the University of Rome, he was not afraid to return to Venice to face the challenges of practice and public debate by taking part in the famous competition for the Barene di Venezia-Mestre (1958).

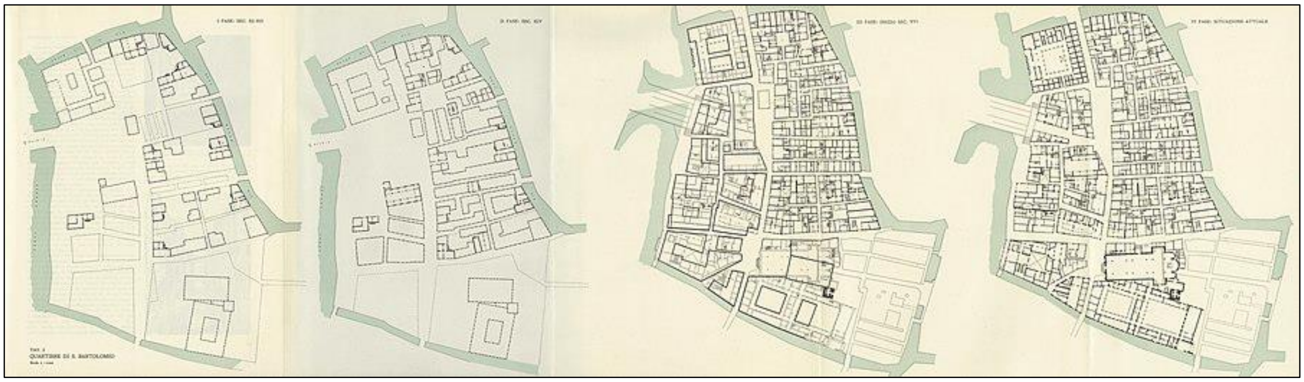


Figure 27 The urban fabric of the S. Bartolomio block in Venice. The three plans that follow each other to the left propose a retrospective periodisation of the phases of formation of the urban fabric. Source (P. Muratori et al., 2002)

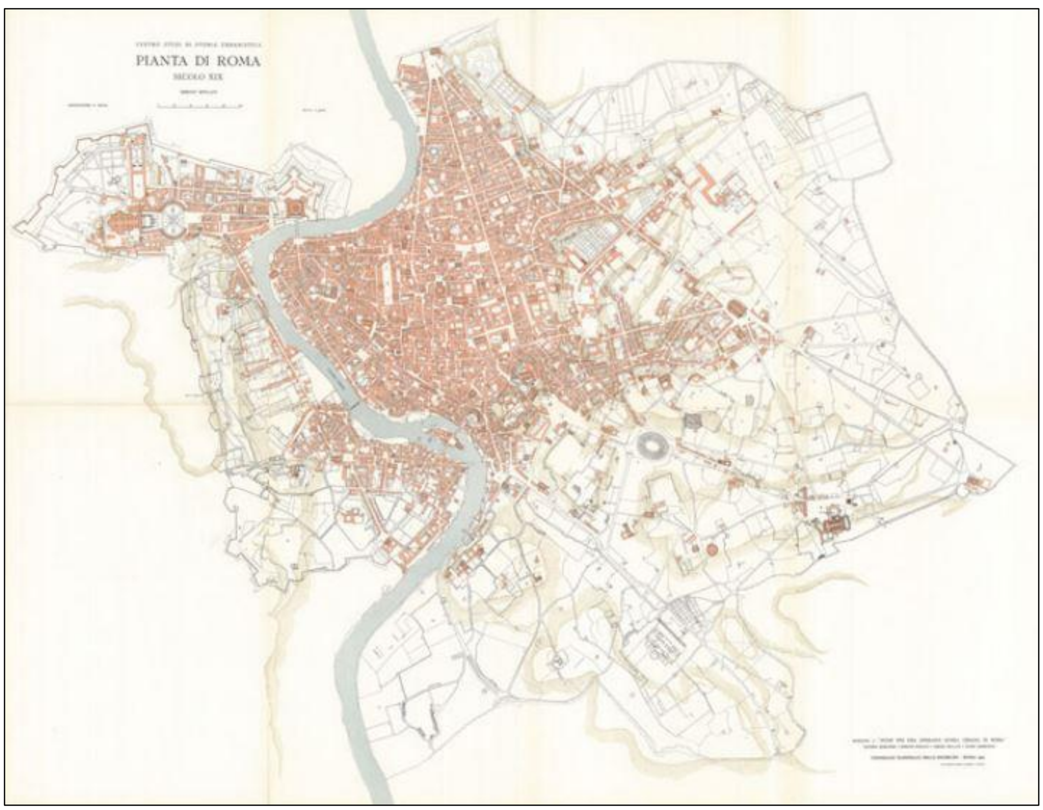


Figure 28 Studies for an operational urban history of Rome.
Source:(S. Muratori, 1959)

After this historical overview, we will summarize in the following the aspect and principles of this school of thought and its contribution to the development of research in urban morphology. established the Italian school of urban morphology and typology in the 1950s. One of its key characteristics was the utilization of urban history to restore a feeling of continuity in architectural practice. For this Italian architect, the 1950s urban and architectural crises was founded on the premise that one could operate effectively in the city by isolating urban phenomena into separate components that, in fact, rely on certain situations. Muratori wanted to construct a theoretical framework to explain the origin of urban form and its evolution across time(Muratori, 1959;urbanistica et al., 1964;Caniggia, 1963;Cataldai et al., 2002). Caniggia's work, combined theory and practice to form a coherent planning approach based on a typological examination of the city, rejecting the project's leadership position. He contended that the architect's right course of action would be to return the project to its proper location after it had been typologically identified(Caniggia, 1963). Authors such as Marzot, Maffei, Cataldi, and Vaccaro(Cataldi, 1998; Cataldi, 2003; Cataldai et al., 2002; Moudon, 1997) are part of the *Centro Internationale per lo Studio dei Processi Urbani e Territoriali* (CISPUT), which was created in 1981. The goal of this center is to promote and advance typomorpholoigical study in the preservation and restoration of building heritage.

(Muratori (1959) introduced certain essential urban notions such as typology, urban fabric, organism, and so-called operative history in the late 1950s. A type cannot be personalized unless in a specific application, in the urban fabric; the urban fabric cannot be individualized except in its involved context, in the urban organism; and the urban organism can only become genuine in its historical dimension. Type is a synthesis, a spontaneous and evolving reality that is inextricably related to a certain culture. Muratori developed his own ideas in 1959, in a competition for the city of Venice, by recreating three major eras in Venice's urban history (according to modern trends), the eleventh century, the Gothic period, and the period between the 16th and 18th centuries.

(Cataldi, 1998) recently emphasized another Muratori notion, creating in phases. According to this notion, an architect might provide a variety of solutions for the same project, which may not be distinct choices to pick from, but rather diverse stages in a single urban process, based on a number of supplied assumptions about the evolution of the urban form. According to (Corsini, 2003), typomorphological study can help to better integrate new interventions within the city's historic continuity. This integration can be accomplished in a variety of ways. First, research several town designs from various eras. Second, working backwards to determine the rules that contribute to the evolution of urban tissue. Third, determining the phases of evolution and picking which phase to enhance in order to construct the most appropriate linkages with the current metropolis.

3.5.1.2 French school of thought

In the 1960s, city research was separated into two schools: Paris and Versailles. Three of the primary writers of the Versailles school, Castex, Depaule, and Panerai(Jean et al., 1980), viewed the city as an architectural product, attempting to analyze various urban elements and identifying some main aims.

These objectives include: connecting a set of urban elements in order to understand modern urban space; reestablishing the dialogue between the city and its architectural history; contributing to the definition of a new architectural model distinct from modernistic proposals; and, finally, gathering the indispensable tools for a city architectural analysis. According to these scholars, the long-term interaction between roadways and urban plots is critical to understanding urban evolution, densification, and ongoing adaptation to cultural, economic, and demographic changes.(Jean et al., 1980)investigated Versailles from a typomorphological standpoint, dividing the city's history into morphological eras and then confronting them with the overall evolution of urban forms and building types. This study demonstrates that the city grew as a collection of urban fragments rather than as a cohesive entity. On the other hand, even a symbolic city like Versailles had devolved into an average city, with enormous urban plots once inhabited by aristocratic houses now occupied by common dwelling units.

Other urban researchers like Darin, (1998); (Minon &Micheloni (1978), (Borie et al., 2008)also (Fortier, 1989) also produced key studies on urban morphology in the 1980s. To further examine the typological and metric linkages of the urban form, the first three writers split it into many components: topography, road system, plots, and constructed form. The fourth investigated Paris, producing a series of twenty urban components that included a tunnel, an aristocratic hotel, and a bridge.

As a result, it is possible to argue that the French school of thought developed as a continuation of the Italian school of thought studies, with the substance of Lefebvre and Boudon's views combined. Among them, Rossi and Aymonino had a greater impact on the French school of thought than other Italian school of thought academics such as Caniggia (Bekkering, 2006)). Some academics claim that there is no such thing as the French school of thought in urban morphology research. Darin, for example, claims that studies conducted within the framework of the French school are dispersed and that its researchers are often unaware of one another. As a result, no one can claim the existence of the French school of thinking (Darin, 1998).

Furthermore, reviewing the existing literature in this field of research, particularly the theoretical framework supplied by Castex and Panerai, suggests a unique type of oneness. Unlike the Italians, who attained their approach to urban morphology via architecture, the French school of thought felt that urban morphology was influenced by the aggregation of numerous fields (Bekkering, 2006). The dual objectives of the Versailles architectural school in the development of a city and the design philosophy of the French school of thinking lead to the accomplishment of various aims, including the following: strong relationship with sociological sciences, evaluating questions of dual connection between individuals and their surroundings, and eventually finding a means to reconcile design theory as practical approach and a theoretical principle (Moudon, 1997)

In their seminal book "Urban Forms" Panerai and Castex (2004)claim : In the 1970s, architects in France were fascinated with methodological-morphological games. Urban planners still believed that the magic of planning was based on big scales, and numerous political groupings were inspired by sociologists who were seeking for city people and condemning bulldozer restoration. They believe that the implications of this form of refurbishment are equivalent to dismissal (Panerai et al., 2004) . As a result, it can be observed that the collection of methods of experts from many disciplines of study with varied viewpoints on the theme of urban form was defined and clarified under the effect of France renovations.

Although there are some parallels between French and Italian schools of thought, there are also considerable variances. These distinctions can be summarized as follows. First, unlike the Italian school of thinking, the French school of thought does not believe in a distinction between "before" and "after" as a result of the evaluation of numerous models and ideas. Nonetheless, it explores how a concept affects patterns, categories, and forms in relation to one another. Second, in contrast to the Italian school of thinking, the French school of thought focuses on either urban patterns or urban tissue (Bekkering, 2006). The most notable feature of the French school of thinking is its analysis of urban form formation ideas. For example, according to study they conducted on several European cities, numerous examples were examined, including the effects of the garden city concept on the London city form, the effects of Haussmann's urban planning on the shape of Paris, and the notion of Le Corbusier's radial city (Panerai et al., 2004). As a result, the primary focus of this school of thinking is on applied Modernism adjustments.

Because modernism and its new spatial idea cannot be explained by traditional morphological analysis, Panerai and Castex performed research that resulted in the establishment of the "Island"1 concept as an essential ingredient required for assessing the twenty-first century city. The definition of "Vertical Island" is a response to Modernism's repercussions and an alternative option for filling gaps in morphological studies in the third dimension. Thus, the French school of thought developed its own framework in order to incorporate observational and perceptual investigations (Bekkering, 2006).

As a result, it can be asserted that the goal of morphological studies in France is, in fact, the evaluation of the amount of realism in various theories, which is based on the evaluation of their impacts on urban forms and patterns, as well as the definition of significant components that are required to redefining the development of new interventions.

3.5.1.3 British school of thought

In the United Kingdom, the word "urban morphology" refers to a variety of various forms of research. Despite the fact that they virtually all focus on the physical forms of urban places, each has been explored by a mostly different set of scholars until recently. Typomorphologists in architecture have traditionally worked independently of those who use space syntax. Similarly, individuals working in the Conzenian tradition in geography have had minimal touch with advocates of spatial analysis. The lack of integration among disciplines has been mirrored by a lack of contact between architects and geographers. If the intellectual commerce that was beginning in the later years of the twentieth century is to acquire speed, the many schools of thought must lay up their stalls.

The British school is the most flourishing study approach in urban-geographic morphology. Moudon (1997) describes this school of thinking as British since M.R.G. Conzen (1977) is the primary researcher for this school. Despite his German origins, he immigrated to the United Kingdom, and his study is focused on his analysis of English cities (Moudon, 1997). However, due to Conzen's German morphogenetic belief, this school, according to Larkham, (2006), can also be dubbed German school. Perhaps it is connected to the propensity of English morphologists to describe and characterize procedural conceptually (Larkham, 2006). Conzen, (2001)concentrated his study on English cities, particularly "Alenwick," in the 1930s. He dubbed these studies "Townscapes," which are a blend of city map analysis, building form, and function. The city map depicts roadways and their connections to the network system, components and their connections to blocks, and block outline (Bekkering, 2006). Additionally, he created two concepts: "Fringe-Belt" and "Burgage Cycle". The former refers to the establishment of restrictions at the urban outskirts during a period when the built-up region was neither developing or increasing gradually. While the former denotes the increasing filling-in of backland burgages with structures, the latter denotes the removal of buildings and a time of urban follow preparatory to the commencement of a reconstruction cycle (Bekkering, 2006;Mirmoghtadaee, 2006).

Conzen introduces "Plan Unit," units that were shaped in distinct morphologic eras, as part of his historic study of urban history. Because each age has its unique set of circumstances, this division is both practical and logical (Bekkering, 2006).

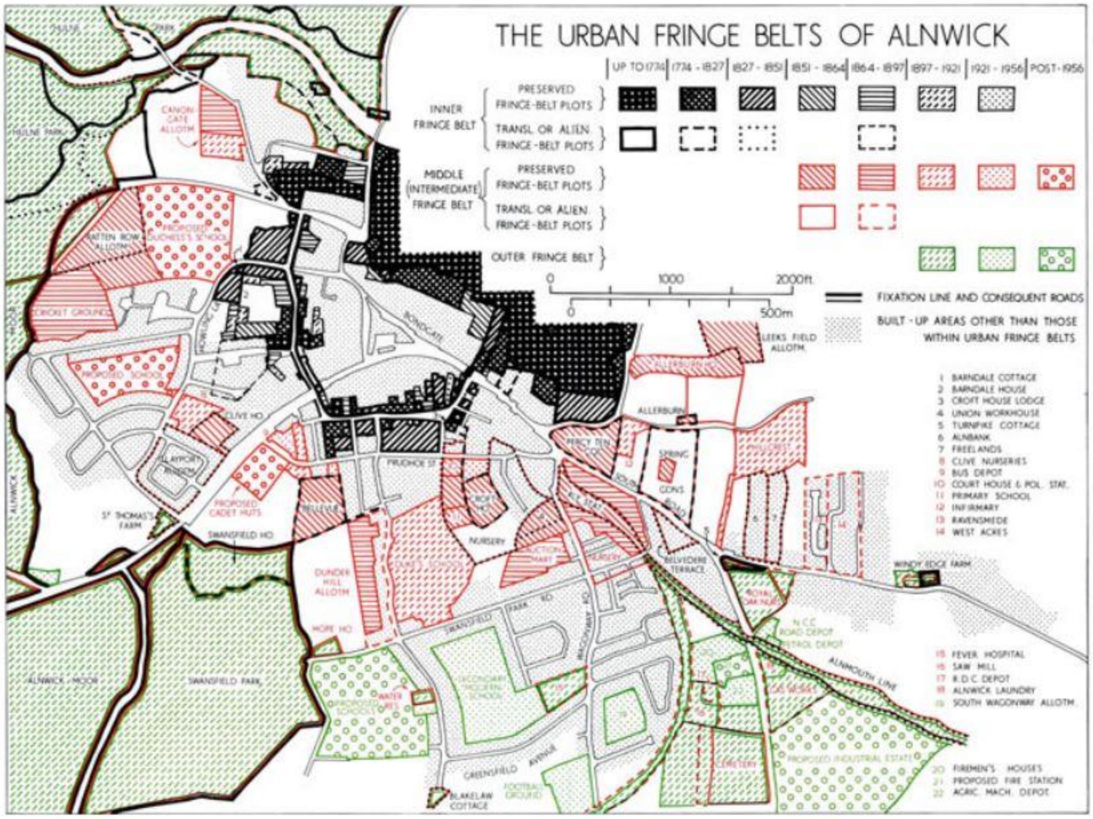


Figure 29 The urban fringe belts of Alnwick.
Source:(Vítor Oliveira, 2016)

Conzen's significant effects on urban morphology research include the following: 1) Taking into account the characteristics and changes in the urban landscape. 2) Establishments engaged in the change procedure. 3) Management of the change (Larkham, 2006). Conzen's concept arose from "Whithand" study (Whitehand, 2001). He enlarged the bounds of urban morphology beyond geography to urban economy, the study of a city's relationship with its residents, and dynamic techniques of building construction. In 1974, JWR Whitehand, (2001) founded the Birmingham Research Center with the goal of researching medieval towns. Furthermore, other persons trained at this research center, such as Larkham and T.R. Slater, perpetuated this school of thinking (Moudon, 1997).

The particular British school of thinking in urban morphology known as Conzenian is unmistakably geographical. It is mostly concerned with how objects fit together on the ground. It's difficult to imagine notions more geographical than the fringe belt concept and the morphological area. They are concerned with the configuration and reconfiguration of the earth's metropolitan areas. The term "morphogenetic" appears to be appropriate, as does the emphasis on cartographic depiction. The overall approach, but especially the way of thinking, language, and visual depiction, is far more German than British. There is no question that if M.R.G. Conzen, (1978) had not migrated to England, the history of British urban morphology would have been significantly different. Nonetheless, there is a lot of contemporary interest in the kind of study that may be defined by that phrase. Some of it is undeniably relevant outside of its home field of geography. Indeed, some of the most intriguing advances in urban morphology in general are those occurring at the intersections between geographical urban morphology and architecture and planning.

Finally we can say that, the British approach is a viewpoint that contends current urban changes are not entirely new; rather, they are a continuation of prior altering processes (Bekkering, 2006). As a result, the British school of thought examines urban morphology studies through the lens of distinct subject domains and a unique approach. Meanwhile, it evaluates the existing condition and the process of change.

3.6 The configurational approach

With the introduction of computers in the 1960s, the most significant breakthrough in urban layout research was geometric freedom. Previously, all aesthetic and morphological analyses of urban planning were carried out using metric geometry and other classical mathematics. This began to change when computers enabled the use of new mathematical theories such as sets, groups, graphs, and fractals, to mention a few, to describe the geometrical features of urban layouts. Some of these confgurational properties employ simple topological concepts such as "adjacent to," "connected to," "in the neighborhood of," and "contained by" that cannot be expressed in metrical forms, shifting the emphasis from a quantitative to a qualitative viewpoint in studies of urban layout incorporating psychological significance.

3.6.1 Space syntax

Space syntax is a collection of methodologies created to study spatial arrangements in relation to activities in the built environment. Space syntax was invented by Bill Hillier and his colleagues (B. Hillier & Hanson, 1989). These strategies are used to imitate people's motions in streets and activity locations. Unlike in trip behavior theory and location theory, distance has no direct bearing on behavior in space syntax. The hypothesis holds that spatial structures influence behavior through influencing people's visual orientation in space. Hillier & Hanson (1989) provide descriptions of the idea. The idea is founded on the concepts of convex and axial space. A convex space is described as a two-dimensional point where all points in space are readily accessible and visible from all other points. An axial space is defined as a location in a convex space that constantly follows a straight line and is immediately accessible and visible from at least some places in other convex spaces. A convex map or an axial map is a representation of a plan system using these components. This is turned into a visual display. This is turned into a visual display. A syntactic step between two axial spaces is understood on an axial map as a change of direction for anybody going between two axial spaces. A line connecting two nodes can also be used to represent an axial space.

Syntactic depth in plan patterns may be analyzed using space syntax. The least number of spaces required to get from space A to space B in a plan system is referred to as syntactic depth. In a plan system, the relationship between each individual space and each other individual space is known as the'relative depth' or 'relative asymmetry.' This is recognized as a good expression to explain the structure of a plan. A justified graph can show the depth of a given space relative to other spaces in a planned system. The word integration refers to the degree to which a space is related to every other space in a system in terms of syntactic depth. High integration values of space suggest close closeness to other spaces, whilst low values indicate distance from other places.

The concept of 'global choice' in spatial planning encapsulates the intricate interplay between spaces within a system. It delves into the nuanced evaluation of spatial connections, where the frequency of a space serving as a pivotal link among various pairs determines its degree of choice. The complementary 'control value' of a space gauges its likelihood of being a preferred option for neighboring spaces, signifying its influence on adjacent areas (B. Hillier & Hanson, 1989).

Furthermore, the 'integration value' and 'degree of choice' establish the fundamental fabric of relationships between spaces, functioning as crucial parameters in a plan system. These attributes portray the system's holistic characteristics, illustrating their relevance in shaping the system's functionality as a unified entity. Their comprehensive nature underscores their pivotal role in defining spatial interdependencies within the designated system, enhancing its overall coherence and functionality (B. Hillier & Hanson, 1989).

Figure 30 British urban form school, combining morphological elements based on street blocks City map (street and their system, land sites, and their assembly in blocks and their design) building's form and function. Source:(Google., 2019)

Theoretical models are used as planning tools to simulate changes in a roadway network. One can direct the geographic distribution of activities and public life inside a community by establishing new linkages (routes) or blocking off existing streets. Streets with high integration values have been found in empirical research to attract more activity and tourists than streets with low integration values. Cities with limited connections to adjacent developments have lower activity than cities with more connections (Klarqvist & Min, 1995,Marcus, 2002,Hiller, 2005)

The degree of integration has also been linked to the distance traveled in road networks. A comparison of distance traveled in street patterns with varying degrees of integration (Hiller, 2005) reveals that the average distance traveled varies according to the street network, with a design with higher integration values in the center and lower in surrounding structures providing slightly shorter distances traveled than the common grid pattern. Other designs provide greater distances. The finding, however, is difficult to understand since it conceals the impacts of network distance and influences from other design factors.

According to Van Nes (2002), the theory may be used to examine the relevance of bypass highways and the construction of activities along the route (Van Nes, 2002). To summarize, humans interact with their surroundings through a variety of psychological processes. Experience happens through the senses and changes depending on the motivation for using space. The experience of the environment is also influenced by activity and speed, and so differs for those who use the area for stationary activities and those who use it for motion.

According to the research, form, functional and environmental qualities, as well as activities in urban space, all have social meanings that impact activity and travel behavior. The classification of area into primary, secondary, and public (Altman, 1975) may be used to examine how communities and districts prioritize between private and public space, as well as private and public activity. The utilization of neighborhood space may be interpreted via social coding of urban space. Social coding might also be used to investigate the power of various road users over urban space and how this influences modal choice.

Space syntactic theory adds to urban form measurements, which relate to the distribution of activities and people in urban space. A value of accessibility is indicated by the 'degree of integration,' which might also be utilized for evaluations of accessibility for different modes of transport. Several studies are challenging to interpret due to difficulty in differentiating the importance of various form and environmental factors. Nonetheless, the findings indicate that this field of study can make a substantial contribution to explaining the impact of neighborhood design on people's activity and travel behavior.

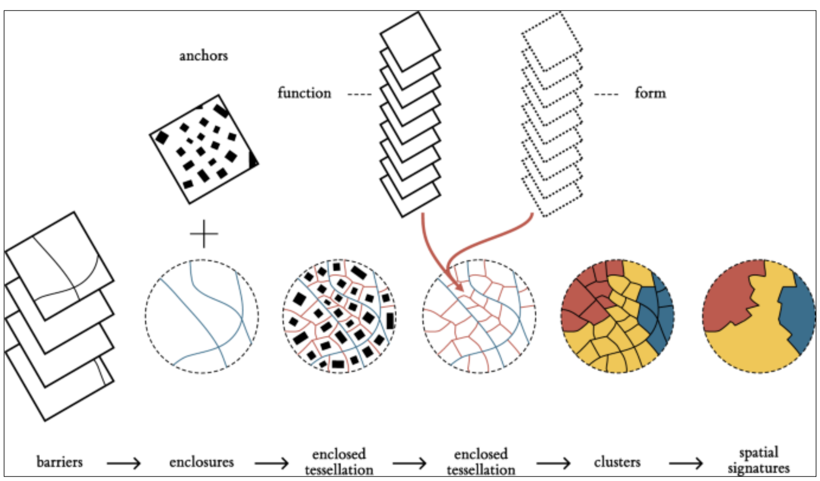


Figure 31 The combination of essential morphological elements measured by Space Syntax source (Alberto., 2019)

Space syntax shows that the fundamental producer of movement patterns is the urban layout itself, and Hillier et al. (1993) refer to the movement created by the layout configuration as natural movement. This implies that mobility has a morphological dimension and is a functional byproduct of the layout's inherent character.

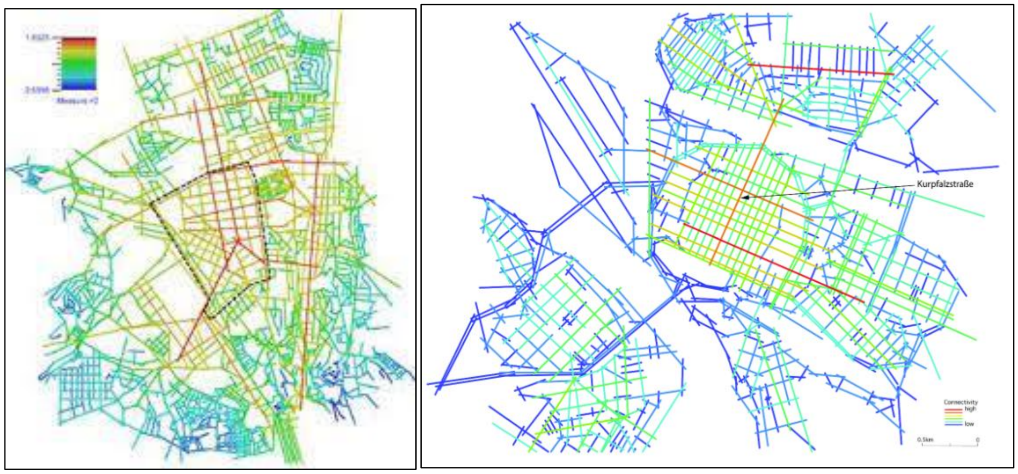


Figure 32. Left: space syntax measures. Source: (Martinez et al., 2018)

4. Urban elements and urban structures

Every human settlement is composed of an almost limitless number of interconnected pieces, ranging from the broadest, such as roads and districts, to the tiniest, such as street furniture and façade details. People usually manage to piece together some form of logical whole from all of the many components that comprise the metropolitan landscape. Lynch's 1964 study of Boston, Los Angeles, and Jersey City was one of the earliest attempts by architects and urban designers to understand how daily users perceive the complex landscapes of major cities (Lynch, 1964).

4. 1 Classifications and relations

There are several methods to classify the aspects of the built environment, each of which is important in its own right but, of course, none of which is exhaustive. A variety of morphological discourses in architecture and urban design begin with the most fundamental forms and volumes and change them with considerable passion. Both solids and voids have been regarded as urban features, which implies that both structures and spaces have been considered. The scientific discipline of urban morphology encompasses many elements of urban form and transition. According to Anne Vernez Moudon, (1997), the field is based on three precepts: urban form is defined by the basic elements plot, buildings, open spaces, and streets; urban form can be understood at various scale levels of building, block, city, and region; and analyses of urban form should take time into account (Moudon, 1997). Urban morphology has mostly arisen from the British school founded by geographer M.R.G. Conzen and the Italian school founded by the architect Saverio. Muratori, (1959). Founders' backgrounds are mirrored in the difficulties addressed in the field today: concerns are mostly handled at the broader scale level of urban geography or at the level of buildings and plots, that is, the architectural scale.

4.1.1 Point, line, and area

The elements of the physical environment are grouped into three structural units in a basic and extremely simple classification: points, lines, and areas. This categorization is founded on basic two-dimensional geometry and may be found in sectors as diverse as art, architecture, and gis (geographical information systems).

In architecture, the morphological approach is primarily static and focuses on how objects seem when seen. To describe urban components, Thiis-Evensen (1999) use the notions of point, line, and grid. All three notions apply to the visual look of the elements; spatial relationships are not examined, and Thiis-Evensen (1999) defines a place's or a street's 'direction' and 'dynamics' as aesthetic factors. All three notions apply to the visual look of the elements; spatial relationships are not examined, and Thiis-Evensen (1999)defines a place's or a street's 'direction' and 'dynamics' as aesthetic factors.

Kevin Lynch's five urban components - landmarks, nodes, pathways, edges, and districts - may alternatively be classified as point, line, and area(Lynch, 1964). The point category is represented by landmarks, which are readily identified physical objects of various scales, and nodes, which Lynch characterizes as crucial locations in urban life or in movement systems. Psychological studies have shown that points, such as landmarks and nodes in the Lynchean sense, are important for urban direction. The points of reference can be either aesthetic or functional; in any case, they appear to arrange the space around them and serve as reference points for less conspicuous components in their surrounds(Tverksy, 2018).

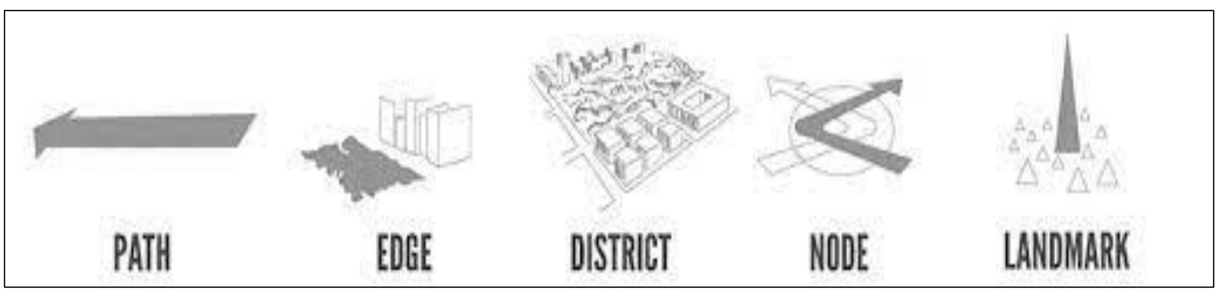


Figure 33 The image of the city's five elements.
Source: (Lynch, 1964)

This is a result of a phenomena known as nesting, which I shall discuss later. Lynch's line category is comprised of edges, which are dividing components (such as borders, obstacles, or 'seams,' and pathways, which are moving channels. As perceivable elements, lines, edges, and pathways are similar, but when it comes to usage, they represent two opposites: the edge as a potential hindrance to movement and the route as a carrier of it. Finally, districts indicate the region type. Districts, according to Lynch, are places that are differentiated by some common and recognizable characteristic. The advantage of these simple classifications is that they are simple to comprehend and integrate with other categories in situations requiring more complicated assessments than visual/aesthetic ones.

Despite being one of the richest and most complex parts of architecture and urban contexts, space is frequently considered in architectural thought as something quite unproblematic and cohesive. In these circumstances, space is viewed as a geometric volume that is more or less regular and defined, and it is assessed based on its spatial expression. However, there are discourses in which the idea of space is so densely filled with substance that it appears overloaded for design purposes.

Space includes social, philosophical, and political aspects, and it is evident that designing is never an innocent act, but the non-physical dimensions of space must eventually be converted to geometry and matter for the real judgments at the drawing board. Forty & Forty (2000)argues that space in architecture did not exist until the late 1800s and is closely connected to modernism. In the German context, the term for room was the same as the one for space. With the development of the concept during early modernism, space was used in three senses: enclosure, continuum, and extension of the body(Forty & Forty, 2000).

Eventually, continuous space became the trademark of modernist architecture and urban planning, and it seems odd that a movement so eager to examine space has also been criticized for dissolving it. Forty believes that postmodernists were uninterested in space and that "more symbolism than "space" existed in postmodern architecture (Forty & Forty, 2000). Roger Trancik's Finding Lost Space: Theories of Urban Design distinguishes the enclosed pre-modern urban spaces from the open spaces of twentieth century planning (Trancik, 1991). He argues that urban space must be visually defined, thus enclosed, to be 'found'. His proposals transform the allegedly lost spaces into visually defined urban space, but his theoretical foundation is too simple to be useful in the complex urban landscape of the late twentieth century.(Krier 1(979) argues that changes in the relationships between the primary urban elements plot (p), street (s), constructed space or buildings (b), and open space (os) call for refined ways of identifying the new conditions. Open space in Levy's terminology is to be understood as squares, gardens, courtyards, and other urban spaces that are not streets. Constructed space no longer corresponds to the plot, and there is no clear relation between one building and another and between buildings and streets or open spaces. Practical concerns justify various simplifications of the idea of space. Space syntax theory employs a visually based notion known as convex space(B. Hillier & Hanson, 1989), which was developed as a tool for analyzing spatial interactions. Convex spaces are utilized to distinguish discrete components from a continuous area (as few and as large sub-units as possible). In a convex space, all components are visible from all points.

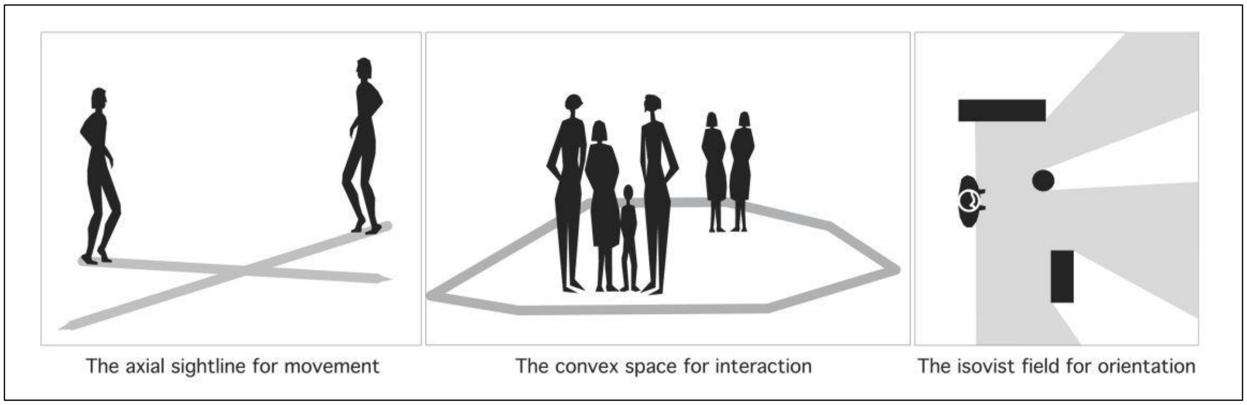


Figure 34 Ways of representing space in space syntax method.
Source (B. Hillier & Hanson, 1989)

4.1.2 Spatial relations and configuration

It's tempting to claim that spatial interactions are the most basic aspects of urban planning. The rationale is simple: all urban life is based on mobility, and spatial interactions define where we may go and how we can get there. Bill Hillier clarifies the distinction between individual spaces and spatial connections in terms of legibility: 'The journey from the simple space to a configuration of space is likewise the passage from the visible to the intelligible(Hiller, 2005). In my examination of legibility, this makes configuration the hidden characteristic of environmental design - it is there, but we don't perceive it. (Garling et al., 2013)have proposed three categories of the way people think of movement in the urban environment: places, spatial relations and travel plans. These three components are interrelated in so far as places have spatial relations, which are ordered in travel plans. Distance, topology, and nesting are important features of environmental cognition. Nesting is a mental phenomenon where sites or areas of different scale become bundled together, so that one is thought of as a part of another. Topology refers to the relations of places or spaces regardless of distance, and nesting involves the hierarchy of spatial memories.

Studies of psychology focus on how we organize the environment in our brains, and how we use this knowledge to create action plans. Studies in architecture focus on the experience of direct encounter, and spatial relations are often treated as the connection between adjacent spaces. Examples of circulation systems are grids, rings, and trees, and common sense can tell us what impact one shape or the other will have on space use and legibility. In terms of legibility, both a ring and a grid are easier to navigate in than a tree, and apartments are more attractive when connected as a ring. However, these space-to-space relationships do not tell us about the overall structural level of the built environment. Studies of psychology and architecture focus on how we organize the environment in our brains and how we use this knowledge to create action plans. Examples of circulation systems are grids, rings, and trees, and common sense can tell us what impact one shape or the other will have on space use and legibility. However, these space-to-space relationships do not tell us about the overall structural level of the built environment.

Many parallels exist between space syntactic theories and environmental psychology concepts. They address urban orientation from two opposing perspectives: psychologists' individual spatial cognition and space syntactic theory. from a structural standpoint. Topology and the fact that both techniques are built on the underlying urban condition of movement are the shared denominators here. Topological relations, according to space syntax, are more important than distance. This is one of the instances where space syntax theory has been called into doubt, but with the psychological studies at hand, it is probable that legibility - and, in many situations, movement - has more to do with how spaces are connected to each other than with distance between them(Penn, 2003). For example, when making trip arrangements, we mentally move around the environment, thinking of areas not as metric units but as things following a sequential sequence or as elements of spatial hierarchies. Thus, in this scenario, it appears acceptable to single out topology as a crucial determining element for the choice of route between two given places, even before distance.

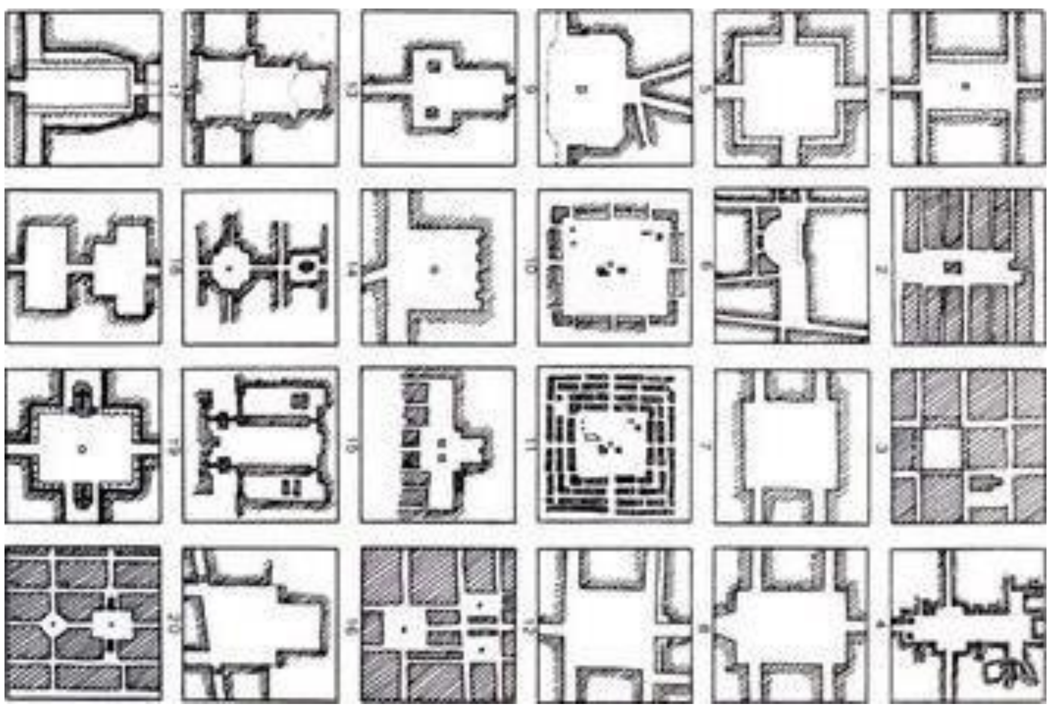


Figure 35 Shows Rob Krier's representation of urban environments utilizing traditional figure ground abstract analysis. Source: (Krier & Rowe, 1979)

The fundamental notions of space syntax theory are provided through visual representations of spatial structures that are easily accessible, such as the justified graphs in Figure 1.2 and the axial maps in the appendix. The areas under consideration might be both rooms in a building and urban places. In both instances to establish the topology of the spatial structure, space syntax analysis employs the building of convex spaces. The convex spaces are connected by axial lines, which are crucial elements since they carry movement in the given environment. The theoretical framework is consistent with the fundamental facts that traveling is essentially linear and that we move through a sequence of places.

Depth, integration/segregation, and connectedness are important and valuable notions in space syntactic analysis. A tree structure, for example, has more spatial depth than a grid, and the branches are less integrated in the spatial structure than the trunk; in a regular grid, all streets have the same amount of connections, and hence the same connectedness. Space syntax analysis is a form of architectural analysis that looks beyond the numbers to understand what they represent. It is based on the condition that changes in connections in one part of the structure affect the configurational properties of the structure as a whole, and that these changes have implications for use. The purpose of the calculations is to figure out how far (in topological steps) it is from each individual space to every other in a spatial structure. The number we get for each space represents how well integrated it is in the structure. Space syntax analyses show an actual correlation between spatial configuration and movement, with the more integrated the space, the more movement will pass through it. Configuration is an underlying pattern used for navigation, and space syntax theory makes an essential contribution to architectural thinking.

5. Conclusion

The goal of this chapter was to provide a conceptual model for the relationships between urban design and behavior that may also serve as the foundation for an empirical research. A single field or theory cannot describe the complex reality encapsulated in the concerns about the relevance of urban design for travel behavior. The literature initially shown that it is appropriate to emphasize correlations at an individual level in order to find pathways between design and behavior. Several fields help to elucidate processes at the individual level. They are primarily viewed as complimentary in this context. The review of approaches reveals that the interactions between aspects of the physical environment and individuals are connected to the cultural traits of the area. This means that an individual's conduct is tied to the selection of people and houses in a neighborhood, as well as the activities that take place there. At the same time, individual acts contribute to the features of the neighborhood. Individual processes are so difficult to disentangle from the neighborhood's cultural relevance. Theories contribute to the explanation of these links in many ways. The economic theory used to explain travel behavior and home location postulates that an individual's selection process is based on predetermined preferences within the context of restricted resources. According to the thesis, an individual has a high level of freedom in respect to her environment. The choice of activity or residence is viewed as a sensible cost-benefit analysis. According to economic theory, the behavioral theory of social psychology sees conduct as being driven by motives based on values. However, in social psychology, motives are considered as being influenced by the social environment. This impact is viewed as a reciprocal interaction between values and conduct, in which behavioral constraints can alter values. This indicates that behavioral constraints put on a population by urban design may eventually result in value adaptation in that community. Behavioral theories in social psychology describe how values and behavior are passed down from one person to the next. These mechanisms are useful at a cultural level of interpretation, explaining the evolution of lifestyles. Individual behavior is considered as being significantly affected by the social environment in sociological theory, where lifestyle theory is predominantly situated. Individualization of society has caused some sections of the sociological literature to include individual choice in behavioral explanations (Miegel, 1993). In certain circumstances, sociological literature has acknowledged urban form as an explanatory variable for behavior, broadening the definition of behavior to include the physical-spatial environment (Lofland, 2017). Without expressly addressing the built environment, behavior theory helps in a variety of ways to explaining relationships between urban design and behavior. Environmental psychology examines the direct interaction between the built environment and humans, focusing on many facets of environmental experiences. Though the morphological studies of urban layout described above indicate conceptual advances on several fronts, it is important to note for the purposes of this chapter that a cross-cultural urban morphological theory has remained a distant goal, owing primarily to the complexity of urban layout and a lack of uniform data on cities from different regions and countries. It is also crucial to note that the morphological procedures outlined above are time-consuming and difficult to implement.

As a result, the use of these methodologies has been restricted to smaller geographic regions or smaller components and processes of larger geographical regions. Finally, to achieve a fuller geometric description of urban layouts, morphological techniques must be integrated with other current geometric approaches, including those discussed in the next section on conformational studies. Rob Krier's postmodernist typology is based on three basic shapes: the square, the circle, and the triangle. He varies these shapes in both two and three dimensions, which is an obvious merit for basic spatial design. However, his work is more normative than analytical and not applicable to modern urban space, such as the large variety of open spaces found in housing estate areas.

ANALYTICAL FRAEWORK

CHAPTER FOUR

SPACE SYNTAX THEORY AND METHOD

1. Introduction

Space syntax is a theory and method for analyzing spatial interactions that was developed in the 1970s by Bill Hillier and his colleagues at The Bartlett School of Architecture, University College London. It entails computing configurative spatial interactions in the constructed world.(Hillier & Hanson, 1989) recognized that by illustrating how structures and settlements play a role in social connections, space syntax may give a spatial comprehension of the social organization in settlements from many cultures.Initially studied and implemented at the size of local towns and buildings, the advancement of computational power has allowed for the analysis of complicated interactions in bigger cities, metropolitan areas, and even entire regions. The application of the space syntactic technique to urban studies, according (Hillier, 2007)**,** consists of four steps. First, the idea of the spatial units under consideration is explained and specified. Second, space syntax refers to a set of approaches for analyzing cities as spatial networks generated by the placement, grouping, and orientation of structures. These methods allow you to examine how a street interacts physically with all other streets in a constructed environment. Third, space syntax provides a set of methods for observing how functional patterns such as vehicle and pedestrian movement flows through cities, land use patterns, area differentiation, crime dispersal, property prices, migration patterns, and even social well-being and malaise are related to spatial networks. Fourth, research findings from space syntax applications have contributed to new theories and understandings of how cities are spatially formed as a result of social, economic, and cognitive factors, and how urban space, in turn, functions as a generative power for societal, economic, and cognitive factors. The space syntax approach has been applied to a huge number of cities in various regions of the world, and a big database of cities that have been analyzed using the space syntax method currently exists (Hillier, 2007)**.**

According to the space syntax method, there is a link between pedestrian and vehicular mobility and the spatial configuration of the street network (Hillier et al., 1993). The space syntax technique identifies regeneration prospects, ensuring that new plans address the spatial potentials of existing urban places. Space syntax analysis may also be used to examine the spatial configuration of fresh design concepts (Cerkauer& Voigt, 2011; Endibargh, 2012; van Nes et al., 2016). For this reason, we have seen that space syntax is the most appropriate method to answer our research question, which revolves around how pedestrian movement reacts to the shape of open space in two different urban forms.

The goal of this chapter is to offer a comprehensive description of the conceptual framework as well as the methodological and theoretical foundations for investigating the built environment using spatial-syntactical analysis.

2. Basic ideas of space syntax

According to space syntax literature, spatial interactions are the most basic aspects of urban planning. The rationale is straightforward: all urban life is based on mobility, and spatial interactions define where we may go and how we can get there. Bill Hillier clarifies the distinction between individual spaces and spatial connections in terms of legibility: *'The journey from the simple space to a configuration of space is likewise the passage from the visible to the intelligible*' (B. Hillier, 2007). In my examination of legibility, this makes configuration the hidden characteristic of environmental design - it is there, but we don't perceive it. So, while views of architecture and urban landscapes as discrete objects (and/or works of art) are mainly static, conceptions of spatial relations and arrangement rely on movement dynamics. We need to wander around a place to appreciate its structure without maps because, as Hillier puts it, "*relationality in space is rarely available to us as a single experience*"(B. Hillier, 2007). Sommy et al., (1986), established three categories of how individuals think about mobility in the urban environment from the perspective of environmental psychology: locations, spatial linkages, and trip plans. The three components are interconnected in the sense that places have spatial relationships that are ordered in trip itineraries (Cohen, 2013). identify distance, topology, and nesting as significant characteristics of environmental cognition. Topology refers to the relationships of places or spaces regardless of distance (a fundamental condition for space syntax theory, which we will return to later); nesting is a mental phenomenon in which sites or areas of different scale become bundled together, so that one is thought to be a part of another.

These psychological studies are concerned with how humans organize knowledge of the world in our brains and utilize that knowledge to develop action plans, among other things. Architectural studies generally focus on the experience that occurs with immediate interaction - how we react, or are believed to react, when we meet the environment. Spatial relations are frequently discussed in architectural discourse as the link between neighbouring areas. Gordon Cullen's illustrations of urban walks, for example, study the visual interaction from one location to the next (Cullen, 2012). Not only does the architecture of the interface between places effect our experience as we go from one room to the next, but it also influences how we differentiate one space from another. As a result, the spatial interface is a crucial aspect of design. Even if we are successful in identifying crucial spatial interfaces, these space-to-space linkages tell us nothing about the overall structural level of the built environment. Grids, rings, and trees are examples of basic patterns of circulation systems at the structural level of spatial interactions. In many circumstances, common sense will inform us what effect one design will have on space utilization and legibility, both in urban and architectural environments. We may expect, for example, that more movement will be detected in the trunk of a tree than in the branches, and much less in the smallest twigs, just as movement will be more uniformly distributed in a grid than in a tree. And flats are often seen to be more appealing when the rooms are connected as a ring since the route option offers more flexibility. In terms of readability, we may make certain assumptions about the three configurations: for example, that a ring and a grid are both simpler to travel than a tree, because a ring is never more than one turn away from our target, while a grid has several paths to our goal. In a tree structure, our goal may be physically close, even visible, but it is far away in terms of real travel (Cullen, 2012).

Topological relations, according to space syntax, are more important than distance. This is one of the instances where space syntax theory has been called into doubt, but with the psychological studies at hand, it is probable that legibility - and, in many situations, movement - has more to do with how spaces are connected to each other than with distance between them. For example, when making trip arrangements, we mentally move around the environment, thinking of areas not as metric units but as things following a sequential sequence or as elements of spatial hierarchies. Thus, in this scenario, it appears acceptable to single out topology as a crucial determining element for the choice of route between two given places, even before distance. The fundamental notions of space syntax theory are provided through visual representations of spatial structures that are easily accessible, such as the justified graphs the axial maps in the appendix. The areas under consideration might be both rooms in a building and urban places. In both situations, space syntax analysis defines the topology of the spatial organization by constructing convex spaces.

The convex spaces are connected by axial lines, which are crucial elements since they carry movement in the given environment. The theoretical framework is consistent with the fundamental facts that traveling is essentially linear and that we move through a sequence of places. Depth, integration/segregation, and connectedness are important and useful notions in space syntactic analysis. A tree structure, for example, has more spatial depth than a grid, and the branches are less integrated in the spatial structure than the trunk; in a regular grid, all streets have the same amount of connections, and hence the same connectedness. The configurational features of spaces are specified by mathematical operations that are straightforward on a fundamental level in space syntax theory. Calculations in a small spatial structure can be done by hand, but in bigger systems, such as entire towns or enormous structures, computers are required for practical reasons (B. Hillier, 2007). These calculations may appear unduly technical and distant from more traditional architectural studies, but when we go past the numbers and comprehend what they represent, space syntax analysis has a lot to offer the study of spatial interactions. The computations' goal is to determine how far (in topological steps) each unique space in a spatial organization is from each other. The number we obtain for each space shows how well integrated it is in the overall structure: if there are few steps between a particular space and all other spaces, that space is highly integrated; if there are numerous steps, that space is spatially segregated. As illustrated in Figures below, space syntax analysis is based on the assumption that changes in connections in one portion of the structure impact the configurational features of the structure as a whole, and that these changes have consequences for usage

(Hillier, 2007). Several empirical space syntax investigations indicate a real correspondence between spatial layout and mobility in both buildings and urban contexts. The more interconnected the area, the more mobility there will be. Of course, this does not happen on an individual basis, but when there is a critical mass of movement, individuals tend to disperse according on integrative principles (Bafna, 2003). As a result, configuration may be defined as an underlying pattern that is used for navigation. Space syntax theory provides an important addition to architectural thought with these insights, particularly the visual representations of configurational systems.

3. Basic Concepts of Space Syntax

Before delving into the fundamental principles of space syntax, we first define the unit of space and its representations. Not only that, but it is also necessary to specify how distinct units of space are connected to or interact with one another. Different representation strategies are used to identify two sorts of unit spaces in space syntax. The specifics are described further down.

3.1. Unit space

(B. Hillier & Hanson, (1989) divide all settlement spaces into two categories: 'closed' and 'open.' Dwellings, stores, public buildings, and all other constructions are closed components. Public areas, streets, alleyways, squares, and so on are examples of open components. Closed elements unite the entire settlement into a continuous system and define a 'open element' through aggregation. Because people may go from any location in a settlement to all other points, the arrangements of closed components dictate the geometry of the open element, making one continuous area rather than discrete pieces. The continuous open area is divided into unit spaces depending on visibility qualities. These unit spaces are called ‘convex spaces’ and ‘axial lines’ (Hillier & Hanson, 1989) are explained below.

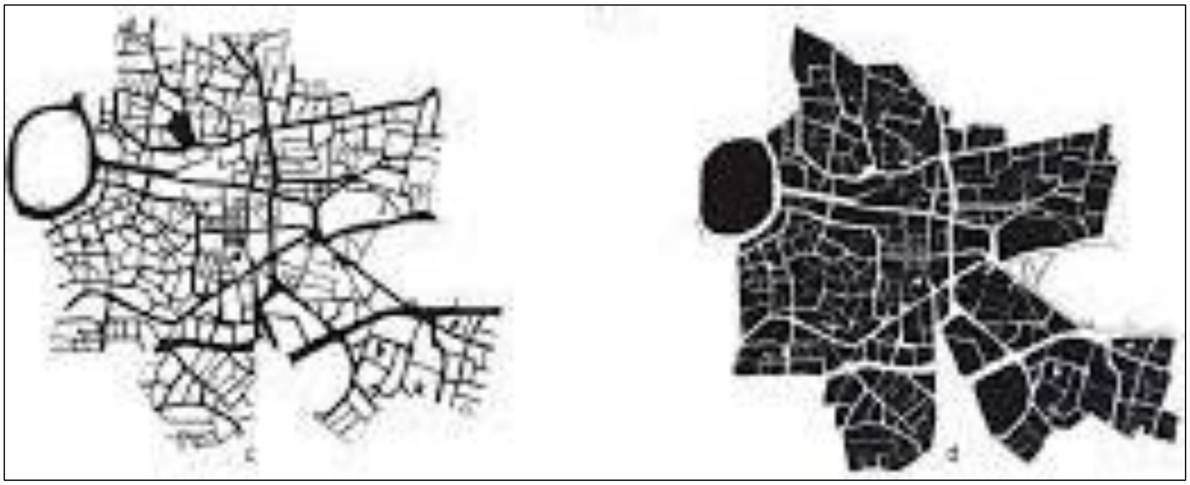
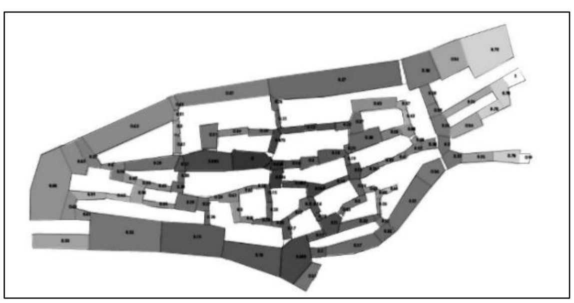


Figure 36 Closed and open spaces of an urban environment.
Source (Vinemen, 2002)

3.2 Convex space

Convex Space is a two-dimensional space where every point is immediately accessible and visible from every other point. In other terms, it is a place in which no line connecting two locations crosses the perimeter or border. Convex spaces are created by drawing the fattest areas in which all points within the border have visual contact (Vinemen, 2002). In the figure. 37, each point within the polygon is visible from any other point, the visibility line connecting the two spots crosses the border. This is a common case in which we need to divide the spaces into smaller convex spaces. There may be an endless number of ways to break the polygon into convex spaces.



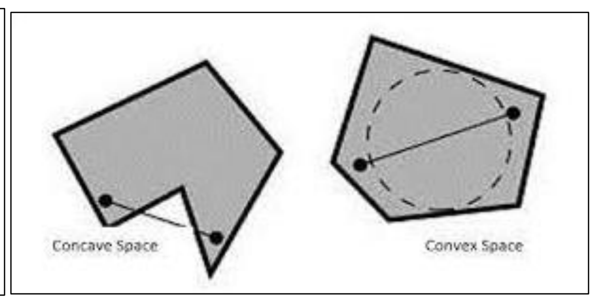


Figure 37 Right Free space is divided into small-scale spaces known as convex spaces
Source: Left the convex space, all points are visible from all other points

As previously explained, Figures 38 depicts how urban continuous space is divided into convex unit spaces. The approach is based on the visibility of points in the unit space from all other points. This is the initial stage in creating another sort of unit space known as an axial line.

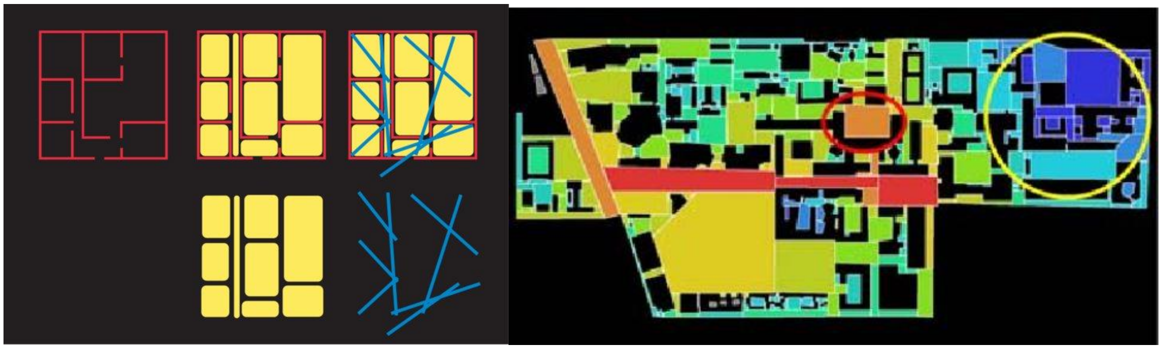


Figure 38 Representation of axial map from convex spaces.
Source: (Osmond, 2011)

3. 3 Axial Lines

Axial space is a one-dimensional space represented by a straight line made between two readily accessible and visible locations in one or more convex units (Hillier et al., 1987). The axial map represents urban space as a matrix of the 'longest and fewest' lines in the system (Hillier, 1999) and serves as the foundation for layout research. Each axial line depicts a real-world space unit called a street, and the node symbolizes the links between urban places. In space syntax, axial lines are employed to simplify relationships between spaces that comprise an urban morphology. As shown in Figure 55, axial lines are formed by drawing a straight line through all neighboring and permeable convex regions until view is hindered.

One of the technique's flaws is the difficulty in drawing the lines. Because there is no one way for generating them, different users create various sets of lines for the same layout. Creating axial lines using graphic software has been a time-consuming manual operation that has been criticized for being time-consuming, subjective, or even arbitrary (Xing & Ghorbani, 2004). We may learn about the nature of the problem by contrasting manually made axial lines with automatically generated axial lines. The comparison of the two extraction procedures revealed two significant discrepancies. To begin, the total number of axial lines generated by the human approach and the auto-generated method were 13 and 14, respectively. Second, there are noticeable geometrical differences between them. Each human created axial line seems to follow the alignments of centerlines (the general angle) of related streets; on the other hand, the auto-generated axial lines diverge from the general alignment of street centerlines.

3.4 Configuration Computations

Configuration is the calculation of connections between spatial units. It computes the depth or number of steps between each space. Before discussing the computing technique, it is simpler to organize spaces in a graph by placing each space adjacent to its immediate neighbor, which is known as a justified graph.

3.4.3 Mean depth

The average number of spaces required to reach all other spaces in the system is defined as the mean depth of a unit space. Each axial line's value is computed by adding the depths of the axial line from all other axial lines in the system and dividing by the total number of axial lines minus one.

$$MD = \frac{\sum_{i=1}^{n} i(S_i)}{k-1}$$

Where, MD = Mean Depth of a unit space, n = Number of level

k = Total number of unit spaces, and Si = Number of unit spaces in a specific level (Hillier & Hanson, 1984).

3.4.4 Integration (Closeness)

In space syntax, 'integration' is a higher-level metric. It is a measure of a street segment's proximity to all other street segments in the network. It describes an axial line's average depth in relation to all other axial lines in the system. As a result, a system's spaces can be classified from most integrated to most separated (Hillier & Hanson, 1989).

Radius may be used to describe the extent of calculation during the integration analysis process. The entire depth of an urban area to all other places in the system is used to examine global integration (integration 'n'). The streets that require the least depth to reach all other streets are referred to as integrated, while those that require a greater depth to reach all other streets are referred to as segregated. Integration can also be studied on a local scale rather than at the network level.

The entire depth of space to all other spaces with the specified radius is used to examine local integration. In the case of radius 3 (R3), just three turns from each street segment designated as a root are tallied. The two integration scales are related with various types of migrations in urban environments.

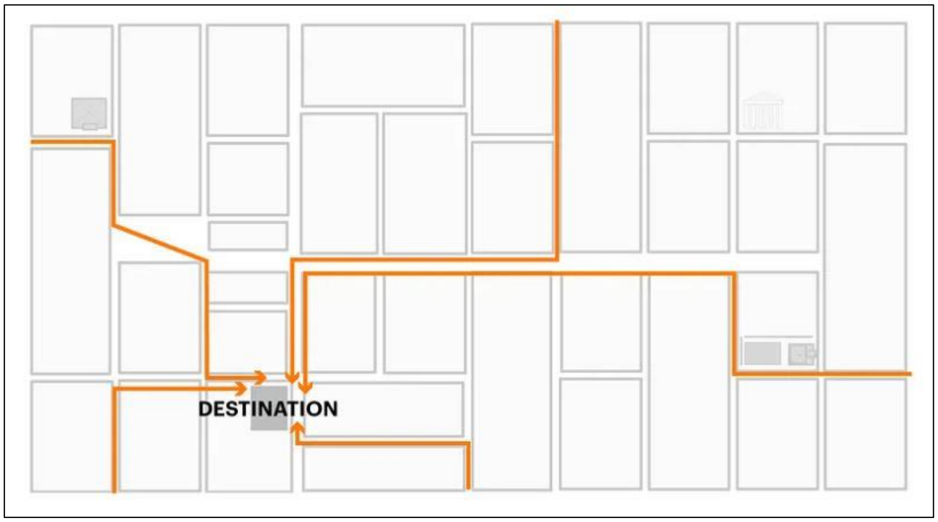


Figure 39 The illustration shows how simple it is to go from several crossroads to the same destination by taking smooth and continuous pathways.
Source: (Turner, 2007)

According to (Hillier, 2014), global integration should be used to predict vehicular movement because people on longer trips tend to read the grid in a more globalized manner; on the other hand, local integration should be used to predict pedestrian movement because pedestrian trips tend to be shorter and read the grid in a more localized manner (Hillier, 2014).

In theory, integrated streets in a system are easily accessible from all other streets. As a result of their configurational position in the complex as a whole, they are deemed more appealing mobility destinations than separated ones. As a result, integration is defined as a measure of 'to movement' (B. Hillier et al., 1993). In other words, integrated places would be an excellent option for travel destinations.

3.4.5 Choice (between-ness)

The quantity of movement that goes through each segment on the shortest or simplest travels between all pairs of (origin and destination) segments in a system is measured as choice (between-ness). It is analogous to the mathematical idea of between-ness. Choice is a measure of 'through movement' since it is about the gaps between origin and goal. A higher option value for a roadway segment indicates that more traffic will travel through that portion of the street. In other words, there would be more cars and pedestrians. The radius examined in the study determines local and global options. There are three sorts of options depending on the concept of distance used: topological choice, angular choice, and metric choice.

3.4.6 Concepts of distance

To represent the relationships between urban places, three distinct distance values might be supplied. The accessibility of each place to all other spaces in the system may then be quantified in terms of shortest length, shortest turns, or shortest angle pathways. Metric, topological, and geometric analysis are other terms for them. The shortest length path is the route with the shortest metric distance, the fewest turns path is the path between spaces with the fewest number of direction changes (smaller topological depth), and the least angular path is the path between origin and destination points in a system with the smallest sum of angular change. The distance notion influences the path chosen between an origin and destination. How individuals move will undoubtedly be influenced by how distance is understood (Hillier & Iida, 2005). Examine the two pathways between segments X and Y in Figure 64, for a better grasp of this topic. There are several ways that might connect the two segments; however, we only wish to compare the two paths labeled path-A and path-B. As previously stated, path selection is affected by the distance notion. Path-A, for example, is 77 meters shorter than path-B since it takes 286 meters (79+90+40+77) to go from point X to point Y through path-A and 363 meters (79+43+71+93+77) via path-B. Topologically, path-A has less turns than path-B; for example, point X is just three steps away from point Y via routeA and four steps via routeB. Route 'B', on the other hand, has a shorter angular turn than route 'A,' with a total angular distance of 2640 (26+93+58+87) and 2760 (90+93+93). As a result, calculating choice (betweeness) and integration (closeness) values in an urban context using metric, topological, and angular distance concepts may provide different answers. Path-A has shorter topological and metric accessibility in this case, whereas path-B has superior angular accessibility.

The examination of urban pathways underscores the nuanced influence of distance metrics. Path-A's 77-meter advantage over Path-B in total distance, coupled with fewer turns, portrays its superior topological and metric accessibility. Conversely, Path-B showcases enhanced angular accessibility despite its longer route and additional steps. These contrasting attributes emphasize the significance of considering metric, topological, and angular distances in assessing betweeness and closeness values within urban landscapes. The discrepancies between Path-A and Path-B highlight the multifaceted nature of urban route evaluation, indicating that different distance concepts yield varied perspectives on accessibility and connectivity in urban environments.

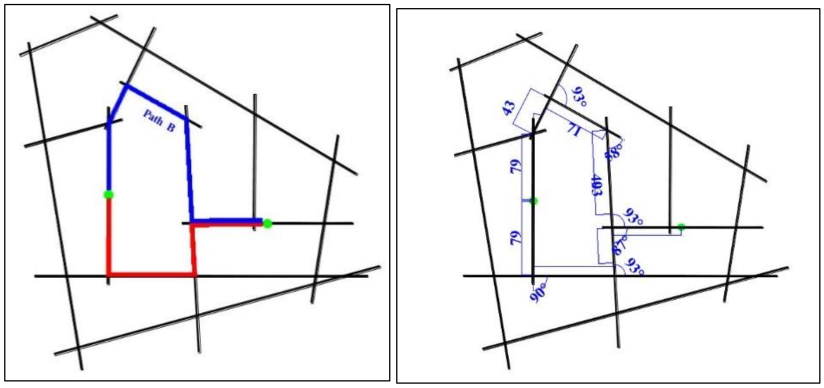


Figure 40 Distances between two points X and Y.
Source: (Barhgie, 2016)

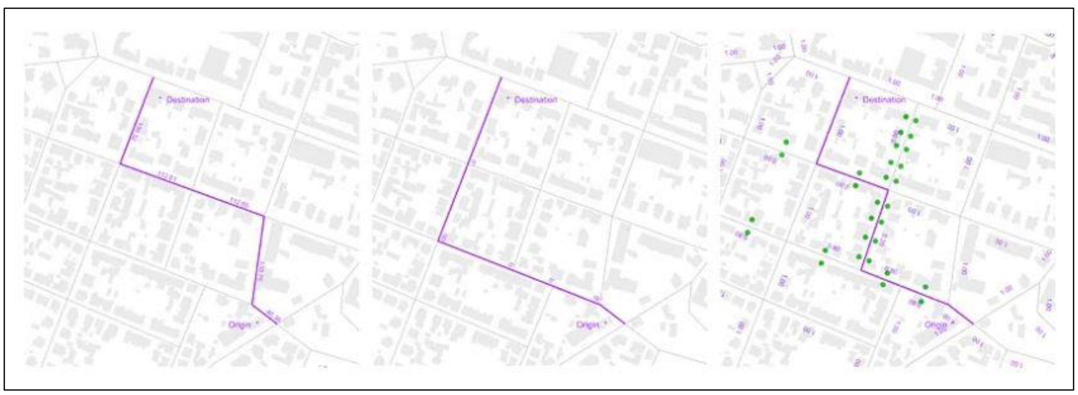


Figure 41 Concept of distance, decoding spaces.
Source: (Turner, 2007)

Six separate linguistic variables are identified under two kinds of accessibility measures, namely integration and choice, based on interpretations of topological, geometric, and metric linkages of spaces,. These interpretations use a similar idea of distance. Both integration and choice are calculated using the shortest length, least angular change, or fewest turns.

There are two scales of analysis for each of the variables (local and global). Global analysis computes each space's accessibility to all other spaces in the system, whereas local analysis quantifies each space's accessibility to all other spaces but only within the defined radius. Radius is defined as the depth from each segment that is considered as a root space. Depending on the study aims, the radius unit might be metric distance, geometrical angle, or number of rotations (topological depth).

For example, when we use topological radius three (R3), we calculate the accessibility of each axial line to all other axial lines within three turns. After three topological turns, it displays how far each axial line is accessible in the locality. Similarly, using an angular radius of R3 (three right angles or 2700) computes the total angular turns of each space to all other spaces within 2700 from the root segment. Metric radius, in the same way, restricts the computation of metric depth from each root space within the chosen metric radius.

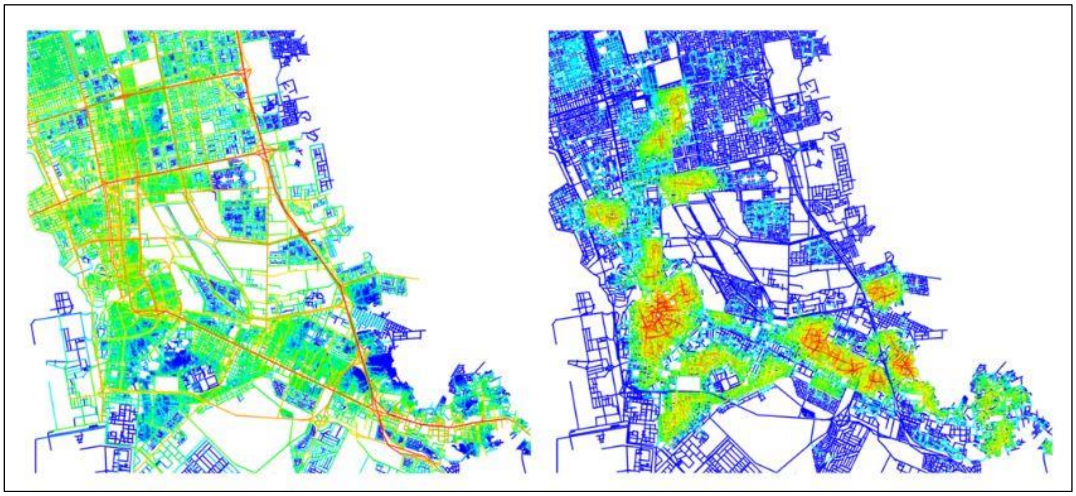


Figure 42 Citywide grid study of Jeddah city (on the left) and local urban grid analysis (on the right)
Source: (Endibargh, 2012a)

3.4.7 Segmented lines

Segmented lines, like axial lines, symbolize urban streets, but they vary in that they are interrupted at each street intersection. As previously stated, axial lines are formed using unbroken visibility; these uninterrupted visibility lines are then split into smaller parts. Figure 67 shows axial line segmentation utilizing a piece of the axial map. The axial line is divided into three segments (m-1, m-2, and m-3) at each street intersection. There is no angular direction change for a movement over an axial line that has been split into several units of space (segment lines). Only when segments are joined with a geometrical angle is angular depth determined. the angular turns from axial line'm' to 'e' are equal, as are the angular turns from segment'm1' to 'e' in. This is due to the fact that the movement across segments'm1','m2', and'm3' is in the same direction, resulting in a total angular turn of zero. The topological turns of all streets do not have identical angular magnitude, which is the basis for angular segment analysis. Topological depth is determined as the number of transfers from one line to another, even when directional change is absent, hence segmented lines are not suited for topological analysis. As a result, axial line m is one step away from axial line 'e', however when axial line m is split, m1 is three steps away from segment 'e'. That is why, for topological analysis, axial lines should essentially be designed as the longest and fewest lines reflecting maximal visibility or permeability.

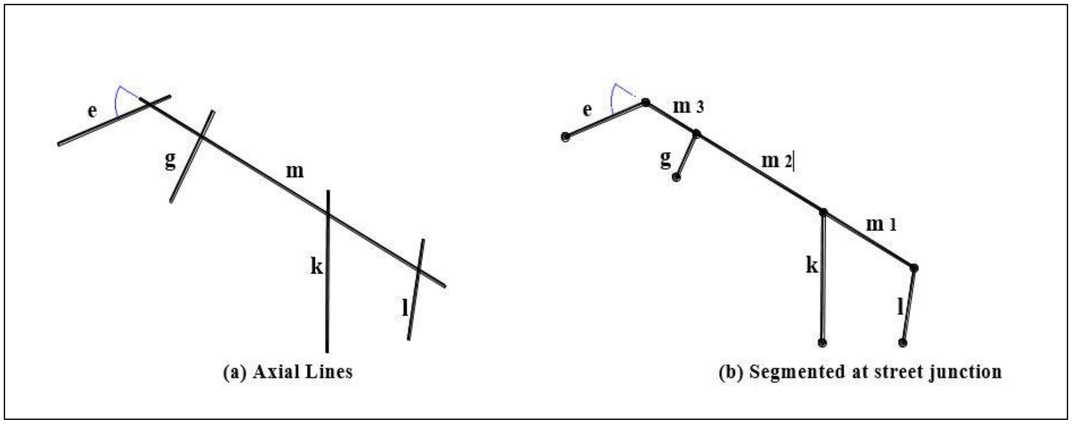


Figure 43 Diagram of segmented lines (portion of the axial map).
Source: (Barhgie, 2016)

3.4.9 Topological Integration

Topological (axial) integration is measured using the word 'depth,' which computes the average number of rotations required by each axial line to reach all other axial lines in the system. Topological integration is a non-metric accessibility metric. When compared to an axial line with a larger mean number of turns (deeper depth), an axial line with a smaller mean number of turns (shallow depth) is regarded extremely accessible (high depth). For example, the nodes at the first level of the justified graph in figure 70 are better linked to segment 'a' than the nodes at levels two and three, since the depth of axial lines from the root space rises as the level increases.

If the average number of levels (bridges) is smaller than in other like sized systems, the overall system is considered to be shallow (more integrated). This indicates that most places in the system are reachable from any other space with fewer turns. On the contrary, a system is considered segregated if the number of bridges is greater than that of other similar-sized systems. In such circumstances, places are not sufficiently linked to be accessible to one another. In other words, there are too many transitions (turns) of movement from one space to the next in the system.

The computation of integration is divided into two phases. First, compute the mean depth of a space, which indicates how deep or shallow the system is from a certain space. The second stage is to compare how deep or shallow a space may conceivably be, resulting in 'relative asymmetry'. The mean topological depth of an axial line is computed by adding the total number of turns to all axial lines in the shortest path and dividing by the number of spaces minus one (Hillier & Hanson, 1989).

MD= L/n-1 Where, MD = Mean Depth of a unit space, L = total depth n = Number spaces in the system. (Hillier & Hanson, 1989) and (Campos & Fong, 2003)

Relative asymmetry (RA) of a space is calculated as:

$RA = 2(MD-1)/ K-2$ MD is the mean depth, K is the number of spaces in the system (Hillier & Hanson, 1989).

Many studies have found a high link between observed pedestrian and vehicular mobility and topological integration (Hillier et al., 1993 ; Hillier, 1999;Penn et al., 1998) and (Hillier & Iida, 2005). With an improved R2 of 0.701, there is a better degree of agreement between local integration of axial line (computed based on topological mean depth) and pedestrian movement in a portion of London (Barnsbury area). Topological integration was shown to be connected with vehicular mobility in the same research of the Clerkenwell area, with an adjusted R2 of 0.819.

3.4.10 Topological Choice

Topological choice is a measure of the number of movements that pass through each segment on travels between all pairings of origin and destination in a system with the fewest turns. The value of choice must be calculated in two phases. To begin, the shortest path from each axial line to all axial lines should be determined using the fewest number of turns. In the second phase, each axial line that is on the determined path is assigned a value of one or zero. An axial line's total topological choice is the sum of all pairs of origin-destination pathways that pass through it.

3.4.11 Angular Integration

The angular integration is determined as the mean degrees of least directional change from one street segment to the rest of the system's street segments. Depending on the street network, pairs of origins and destinations may have various pathways, but the angular changes are not the same. As a result, the path with the fewest angular changes is chosen when computing mean angular changes for each pair of origin and destination spaces. For example, in Figure 71, the shallowest angle route between segments 1 and 15 was calculated.

3.13 shows a comparison of four pathways labeled Path 'a', 'b', 'c', and 'd'. Path 'a' consists of segments 1,4,8,17,16,15, path 'b' of segments 1,5,9,17,16,15, path 'c' of segments 1,5,10,11,15, and path 'd' of segments 1,2,6,11,15.

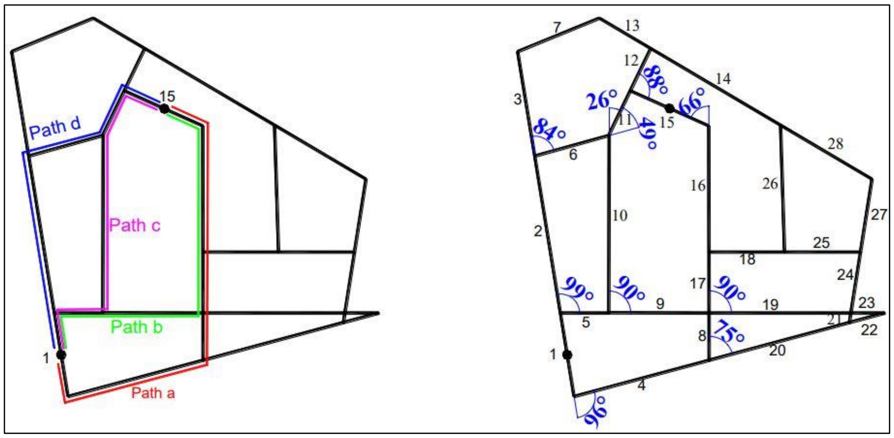


Figure 44 Angular measures of segmented lines.
Source: (Barhgie, 2016)

Right angles are used to indicate units of angular depth (1 means 900). It is determined by dividing the total directional changes by 90. $Angulardepth = \sum \theta$ 90 (Turner, 2001) The angular depth of each route is calculated as follows:

• Path angular depth a = (96+75+66)/90 = 2.63

• Path angular depth b = (99+90+66)/90 = 2.83 • Path angular depth c = (99+90+26+88)/90 = 3.4

•Path angular depth d = (84+49+88)/90 = 2.44

Based on the preceding computations, path 'd' is the shortest angular route between segments 1 and 15, with a total depth of 2.44. The angular depth of segment 1 to all other segments in the system is computed using the same approach to get its mean angular depth (angular integration). A segment's mean angular depth is derived by adding its angular depth to all other segments and dividing by the number of spaces minus one. The mean depth in angular terms for segment x with n segments is (Turner, 2007):

$$\overline{D_\theta} = \frac{1}{n}\sum_{i=1}^{n} D_\theta(x,i)$$

Where D is the geometric angle of each turn divided by 90, n is the number of segments in the system, and D is the mean depth of a unit space. The greater the segment's mean angular depth, the more integrated it is, and vice versa.

3.4.12 Angular Choice

The amount of movements traveling through each segment on trips between all pairs of segments is measured by angular choice. It is determined by producing the least angular pathways with the lowest angular cost for each conceivable origin and destination pair of segments. If a segment is part of the least angular path, it is allocated a value of 1, otherwise it is assigned a value of 0. Path 'd' was found to be the least angular path between segments 1 and 15 in Figure72, As a result, the travel following path 'd' should pass via segments 2, 6, and 11. As a result, for this specific travel, these segments are assigned a value of one and all other segments are awarded a value of zero. The procedure is repeated for each pair of origin and destination segments in the system. A segment's total angular choice is calculated by adding the values supplied to it for each pair of origin and destination journeys. The greater the value, the more the variety. Hence, given a graph with n segments, the angular choice (between-ness) of segment x is defined as follows (Turner, 2007):

$$B_\theta(x) = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}\sigma(i,x,j)}{(n-1)(n-2)/2} \quad \text{Such that } i \neq x \neq j$$

For all possible I = origins, j = destinations) pairings

A issue occurs in segment analysis when correlating with movement. The fluctuation in segment length is not accounted for in the choice measure. "Longer segments are likely to lead to more travels, simply because more plausible origins and destinations may be placed along them," Turner said (Turner, 2007). In other words, because the number of parcels (buildings) next to longer segments is likely to be greater than the number of parcels adjacent to shorter segments, longer segments would create and receive more movement than shorter segments (Figure 3.14 Long vs. short segments).

Turner, (2007) proposed a solution by weighting the choice with segment length; hence, a segment's contribution to the choice values of the intermediate segments in the path would be proportionate to their length. The weighted choice of a segment is calculated by multiplying the segment's choice value by the lengths of its related origin and destination segments. If the path between segments x (origin) and y (destination) includes segment z, the weighted choice for segment z is determined as the choice value of z multiplied by the lengths of x and y. (Weighted choice of z = option * x * y, where x is the length of the origin segment and y is the length of the destination segment. The weighted options for x and y (origin and destination) for the same route are the products of their respective choice values and half of their own lengths (Weighted choice of x = choice * x/2 * y/2). This is due to the assumption that most travels begin and end in the middle of each section.

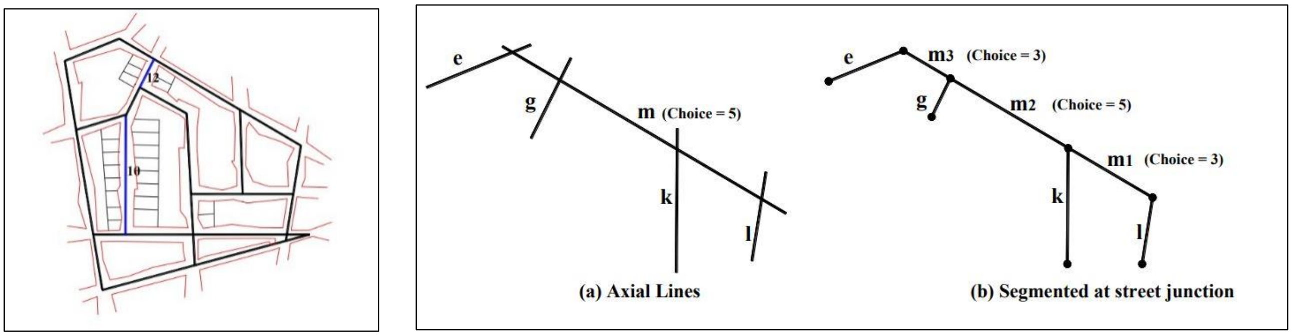


Figure 45 Left: short segments and Long segments.
Source: (Barhgie, 2016)

Despite a promising outcome in describing observed pedestrian and vehicular movement (to-movement), topological integration (Hillier et al., 1993; Hillier, 1999; Penn et al., 1998). According to Hillier, (1999) and Hillier & Iida, (2005), axial lines have limits in detecting a very important configurational attribute termed choice or betweenness, which is related with 'through movement'. Betweeness is the property of centrality of locations that has the advantage of linking as many pairs of sources and destinations as feasible. (Turner, 2001) was the first to propose angular accessibility analysis. He employed this metric to discriminate between possible origin-destination (O-D) paths based on the total amount of angular shifts. Turner introduced the approach of computing angular mean depth in angular analysis to quantify the amount of angular turn required to reach all other lines (Turner, 2001). Angular analysis, unlike topological analysis, is founded on the fact that not all turns are geometrically equivalent. As a result, places with shorter mean angular turns to all other spaces in the system are more accessible than spaces with longer mean angular turns to all other spaces in the system. As a result, routes with larger angular twists are likely to be avoided in urban commuter trip path selections. One of the issues with axial lines is that in topological analysis, a street represented by an axial line is assumed to be homogeneous regardless of its metric length. This assumption falls short of describing the disparities in betweenness along the roadway. There are five pairs of origin-destination motions that pass over the axial line m, as shown in Figure 72 left (these are paths e-g, e-k, e-l, g-k, g-l, and kl).). Nevertheless, after segmenting the axial line m as shown in Figure 72 right , the segment lines m1 and m3 are laid between three routes (i.e. m1 is between routes e-l, g-l, and k-l). In contrast to segments m1 and m3, section m2 is located in the middle of five routes, allowing for greater passing traffic.

3.4.13 Metric Integration

Metric integration is a measure of accessibility based on a segment's metric distance from all other segments. The integrated segment has the smallest mean metric distance from all other segments in the system. The length between the midpoints of the origin and destination segments, as shown in Figure 73, is the metric distance between two segments. As a result, the metric distance between segments'm1' and'm3' is equal to the total of half the lengths of the origin'm1', half the length of the destination'm3', and half the length of the intermediate segment'm2' = 96 2 + 132 + 54 2 = 207 meters. The distance between adjacent segments'm1' and'm2' equals the distance between their mid points, which is 96 2 + 132 2 = 114 meter.

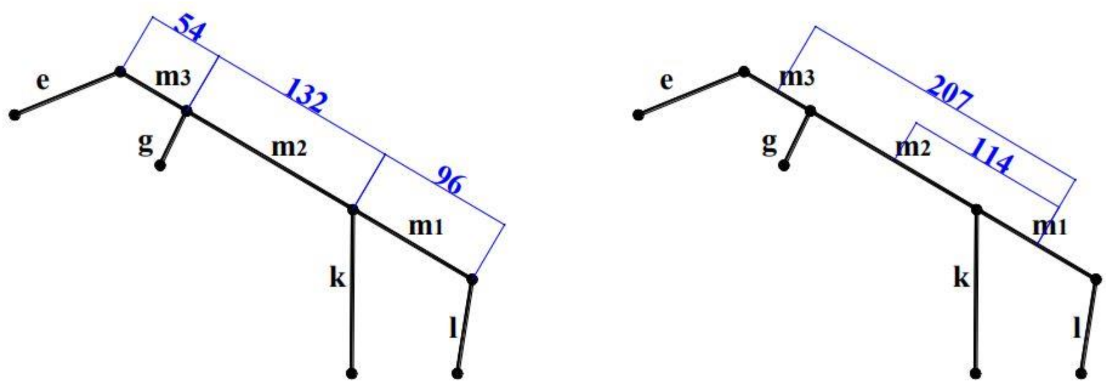


Figure 46 Metric distance between segment lines.
Source: (Barhgie, 2016)

3.4.14 Metric Choice

Similarly, the number of movements traveling via each segment on journeys between all pairs of segments in a system based on the shortest metric path is referred to as metric choice. Metric choice is calculated in the same way as angular or topological choices, except that metric distance is the unit used to determine the shortest path between each pair of origin and destination. (Hillier & Hanson, 1989) discover in the Social Logic of Space that the network itself is responsible for making some of its units more integrated than others. Places that are more accessible will presumably be more appealing as destinations than those that are less accessible, just because of their configurational location in the complex as a whole. While being driven by the aggregation of individual decisions, the bias towards more accessible sites for mobility is a network effect due to the network's configurational nature (Hillier & Iida, 2005).

4. Space syntax applications

Throughout the last two decades, space syntactic theory has given critical computational support for the advancement of spatial morphological research, particularly urban system analysis. It has been widely used for modeling pedestrian and vehicular movements, crime analysis**,** traffic pollution control, and way finding processes. Space syntax has also been used to model property value, land use pattern, notably retail and commercial activity places. Space syntax is a configurational description of an urban structure that aims to describe human behaviors and social activities from the perspective of spatial configuration. The majority of space syntactic studies are concerned with urban patterns, although the approach is equally applicable to research on the scale of urban design and architecture.

5. Spatial Syntax and Urban Studies

5.1 Djeddah study

The Space Syntax approach has emerged as a pivotal tool in numerous city-scale urban planning endeavors, leaving an indelible mark on projects spanning various global locations like Riga in Latvia, Chung Chun in China, and Derry in Northern Ireland. Notably, the application of this methodology extended to the creation of a Spatial Planning Framework for Jeddah, Saudi Arabia, where collaborative efforts involving key city officials significantly shaped urban strategies. The Strategic Planning Framework, in conjunction with subsequent urban design initiatives, exerted considerable influence on strategic and detailed projects, culminating in the adoption of the Jeddah Strategic Plan (Municipality of Jeddah, 2009). This transformative journey commenced with an extensive segment-angular analysis encompassing the entirety of Jeddah, forming the basis for composite urban models that integrated factors like population density, land use, vehicular movement, and socioeconomic conditions. The amalgamation of these diverse elements underscores the comprehensiveness and significance of the Space Syntax approach, showcasing its profound impact in guiding urban design and planning initiatives toward more holistic and informed decisions that shape the future of cities.

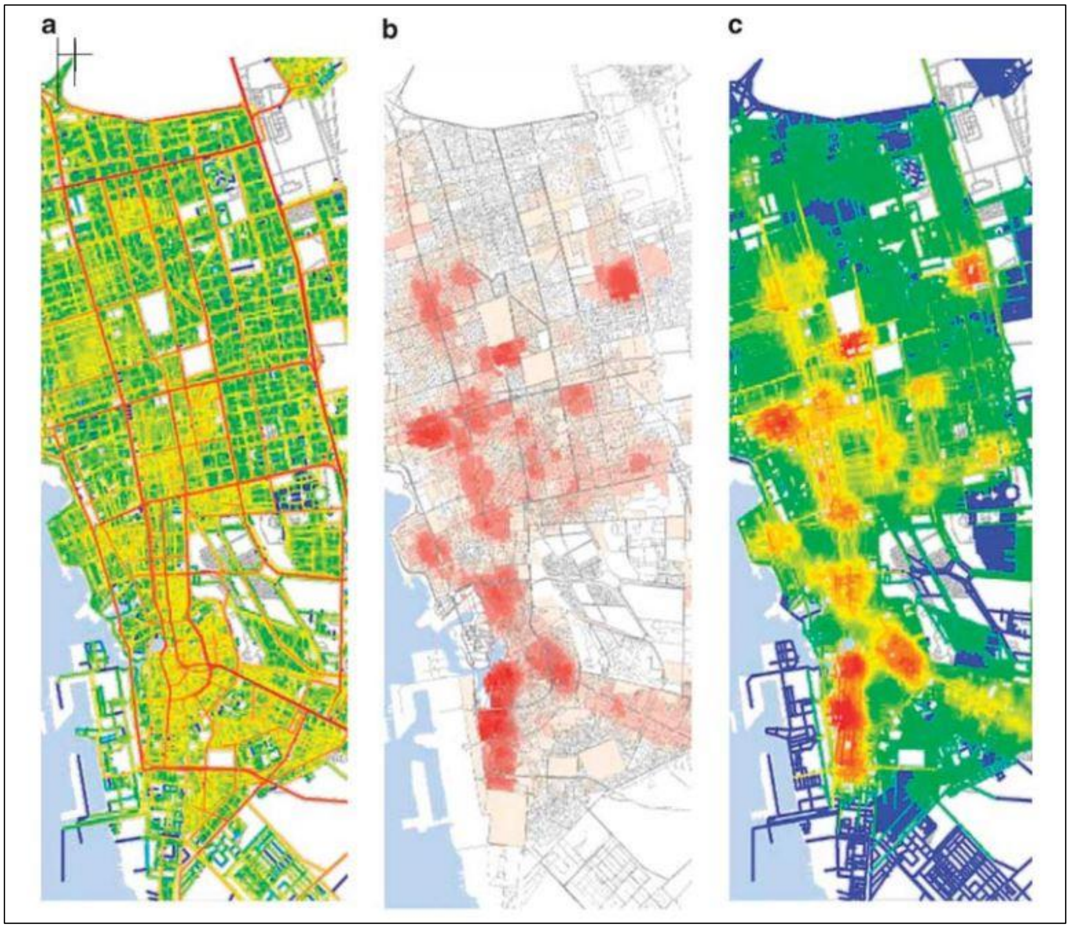


Figure 47 Models of cities that are composites.
Source: (Endibargh, 2012a)

The global analysis of the city revealed major problems with the urban structure, including: extreme isolation of the historic core; a lack of a proper City Centre; an excessive shift of the center of urban structure to the north of the city; imbalanced urban growth and sprawl; negative impact of undeveloped mega-scale sites in the heart of the city on their surroundings; and spatial segregation of unplanned settlements, which were rapidly turning in (Figure 79). These findings were consistent with earlier studies conducted prior to the Strategic Planning Framework, the opinions of the city's expert voiced in stakeholder workshops throughout the project, and the qualitative observations made by the project team. The status quo study was then compared to the analysis of the city's Local Plan (Figure 79). This comparison revealed that the proposed Local Plan will further exacerbate the aforementioned issues. Under the Local plan, the city's integration center transfers to the east, where an intercity highway looks to take over the function of the primary urban spine. The city's historic core becomes considerably weaker, and main east-west arteries emerge as the future city's linear centers. The separation between core and periphery unplanned settlements, as well as extensions to the north, south, and east, is overly emphasized (Endibargh, 2012a). The city's historic centre deteriorates significantly, and major east-west highways emerge as the city's future linear cores. The distinction between core and peripheral unplanned communities, as well as north, south, and east expansions, is overstated (Endibargh, 2012a).

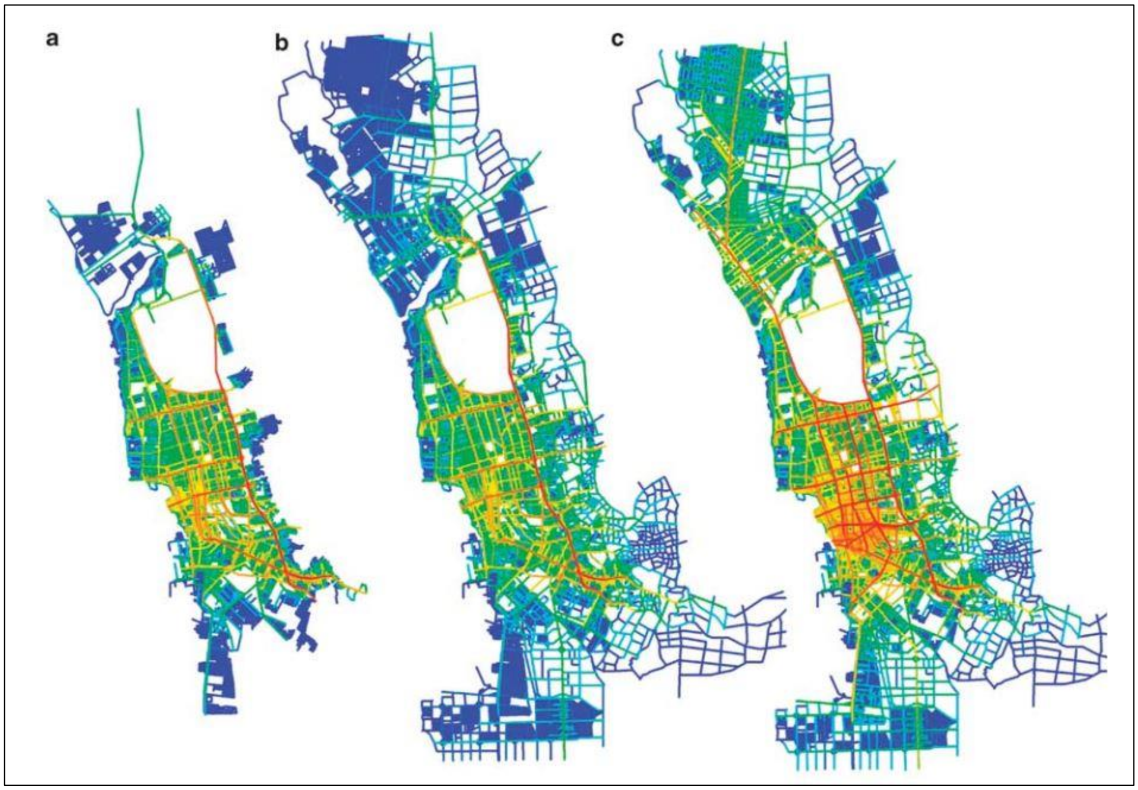


Figure 48 Spatial syntactic representations of the Saudi metropolis of Jeddah.
Source: (Endibargh, 2012a)

5.2 Berlin study

Figure 82 shows a study is cited in (van Nes, 2017), it depicts the urban transformation in Berlin between 1988 and 2005 using the metric of integration. According to the 1988 integration research, Kurfürstendamm and Tauentzienstraße are the most integrated streets in West Berlin. Alexanderplatz is the most integrated East Berlin location. Alexanderplatz was the urban center of East Berlin, located at the confluence of the closely linked streets Frankfurter Allee and Greifswalder Straße. In the study, Kreuzberg and Wedding are separated regions, denoted by green and blue axial lines, and suffer from the isolated position produced by the Berlin Wall in West Berlin. The primary urban centre of reunified Berlin has migrated to Friedrichstraße, according to an integration analysis conducted in 2005. Friedrichstraße and Potsdamer Square were the most integrated parts of undivided Berlin in the 1930s, but they were separated regions throughout the wall's existence. The internationally connected, i.e. citywide, Friedrichstraße is now Berlin's high street, equivalent to Oxford Street in London (van Nes, 2017). Active land use, such as stores, is sensitive to altering centralities, as Berlin vividly demonstrates. The previous urban main centers of Alexanderplatz and Kurfürstendamm have lost their extremely central position in the urban system with the collapse of the wall, and Friedrichstraße and Potsdamer Platz are now Berlin's urban main centers. As a result, the two centers around Alexanderplatz and Kurfürstendamm thrived throughout the wall's existence, whereas the other two centers around Friedrichstraße and Potsdamer Square declined during this time and blossomed again once the wall was down. Kurfürstendamm is now a high-end luxury retail street (van Nes, 2017).

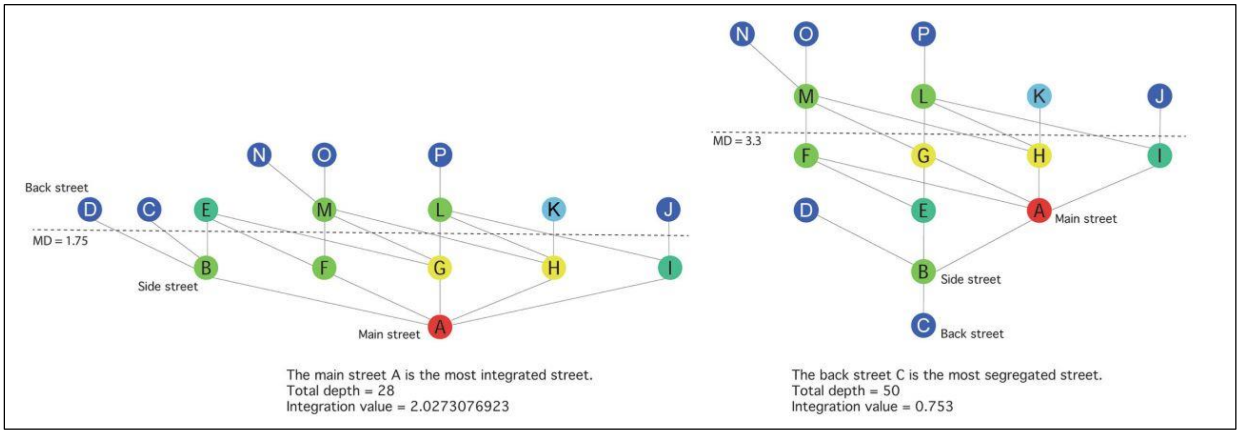


Figure 49 Comparison of two justified graphs with the root nodes of a dead-end street and the main street (google,2020).

Surprisingly, premium companies are frequently positioned on streets with excellent connectedness to their surroundings. Some premium firms avoid streets with the greatest levels of integration in order to reduce the influx of random clients from mainstream culture. The majority of mainstream customers come to look but cannot afford to buy. (Dasyles, 2000) researched how land values changed in Berlin before and after 9 November 1989, and he found that real estate prices increased in places where street network integration values improved following the dismantling of the wall. The Berlin example exemplifies the dual problem of global integration analysis. Secondly, the urban fringe and suburbs are emphasized as highly segregated regions along the system's perimeter, which is referred to as the 'edge effect' in the research. Second, many cities have many centers, ranging from the city's main center to neighborhood commercial streets. The city's primary center is highlighted by global integration analysis, whether the center is a car-based retail mall or a pedestrian-friendly high street with nearby streets. Local sub-centres are frequently overlooked in global integration analyses (van Nes, 2017).

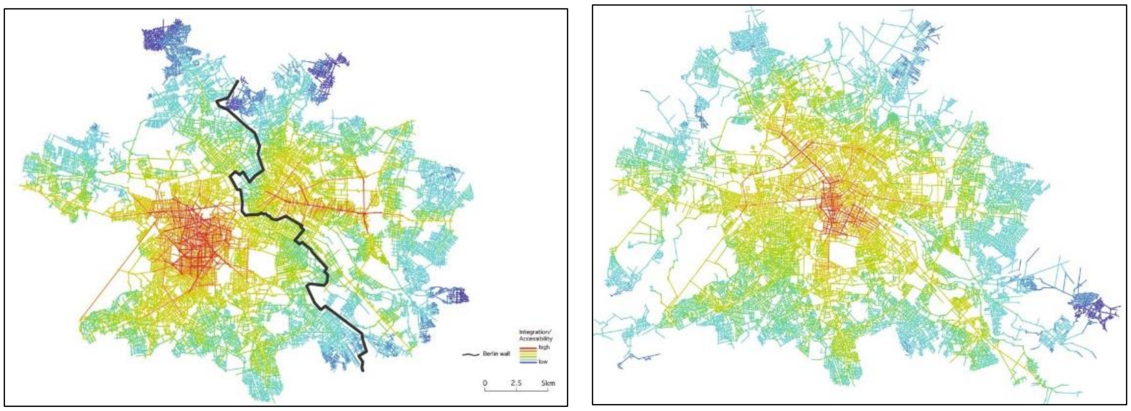


Figure 50 Global integration analysis of Berlin in the area of the Berlin Wall in 1988 (google,2020)

Space syntactic technique was applied in all of these projects throughout the baseline investigation and analytical assessment stages. In the most recent study of this type, conducted in 2011, a composite model that takes spatial structure, land use, density, and road capacity into account was used to assess the impact of all masterplans developed for the City Centre of Jeddah on the definition, boundary, movement flows, and vehicular traffic of the City Centre (Figure 14). This is a cutting-edge tool that might provide input into the design process for each of these projects as well as the city's overall strategic plan.

6. Criticism of space syntax analysis

Space syntax is a young, diverse, and expanding subject of study. It is also contentious. Opponents of the idea argue that because the procedures must be altered and the results interpreted for each new situation, they are not generally applicable and hence not scientifically credible - the researcher is unsure whether the environment or the method is being examined. Some opponents say that space syntactic analyses just corroborate what intuition already tells us.

The newbie to axial analysis's initial worry is undoubtedly connected to its topological representation of the city, which discards any metric information. When addressing pedestrian decision making rather than urban layout, the difficulties in adopting this becomes evident. Persuading a pedestrian that his urban mobility approach is not viable based on metric distance but topological distance might be as tough as convincing a New Yorker who lives on Fifth Avenue between 111 and 112th Streets and commutes to Central Park north around the corner (two directions change on the axial map) or to Columbus. He added that, The same circle (a few miles away, but still two changes of direction). How is this possible? "*The explanation rests in the hidden role of geometry*," writes (B. Hillier, 1999). His argument is well-developed. Simply said, if a regularly organized system is studied, where all of the lines in the axial map are the same length and intersect at their extremities, then metric and topological measurements are the same.

Cities are plainly more complicated than regularly organized systems, with changeable and uneven shape. Yet, recurrent patterns emerge: Hillier, (1999) observes that "the longer the line, the more probable it is to have an extremely obtuse angle of incidence at (or near to) one or both of its ends. In contrast, the shorter the line, the more probable it has a near right angle of incidence at its terminus." This "indicates a constant creative process at work" Hillier, (1999). Because of these ubiquitous regularities, he believes that the axial map does not disregard but internalizes space's geometric features. As a result, its investigation is sufficient to offer useful knowledge on urban systems, and geometrical data can be ignored. According to, although this argument is compelling, it would require more proof to be fully convincing: the hidden role of geometry in cities should not only be posited, but backed by statistical data from a number of real cities. He aseked: "*Would the regulations apply to everyone? If not, what are the prerequisites for using space syntax analysis*?", when examining the applications of space syntax to urban planning, an additional practical difficulty arises. Bundcock, (2004), wondering whether one can expect that, if pattern recurrences are discovered after the fact in cities due to their evolving nature (which justifies the removal of all metric information), they will be present in any design option, in a Zaha Hadid masterplan or in other grandiose projects without a pattern?

Yet, regardless of how important it is for comprehending the built environment, the notion of spatial arrangement depicts space as rather abstract - stripped of all its sensory characteristics, as it is in space syntactic theory. If configuration is stated to represent hidden aspects of the constructed environment, we employ various types of visible properties to navigate through it. Although some of these points have been recognized in part by previous authors (including Hillier), they have never been addressed comprehensively. Moreover, the discontinuous character of axial map transformations and the axial map edge-effect do not appear to have been studied previously. Both exhibit a type of short-circuit phenomenon that occurs when dealing with topological representations of cities under particular geometrical constraints (Xiao & Xiao, 2017).

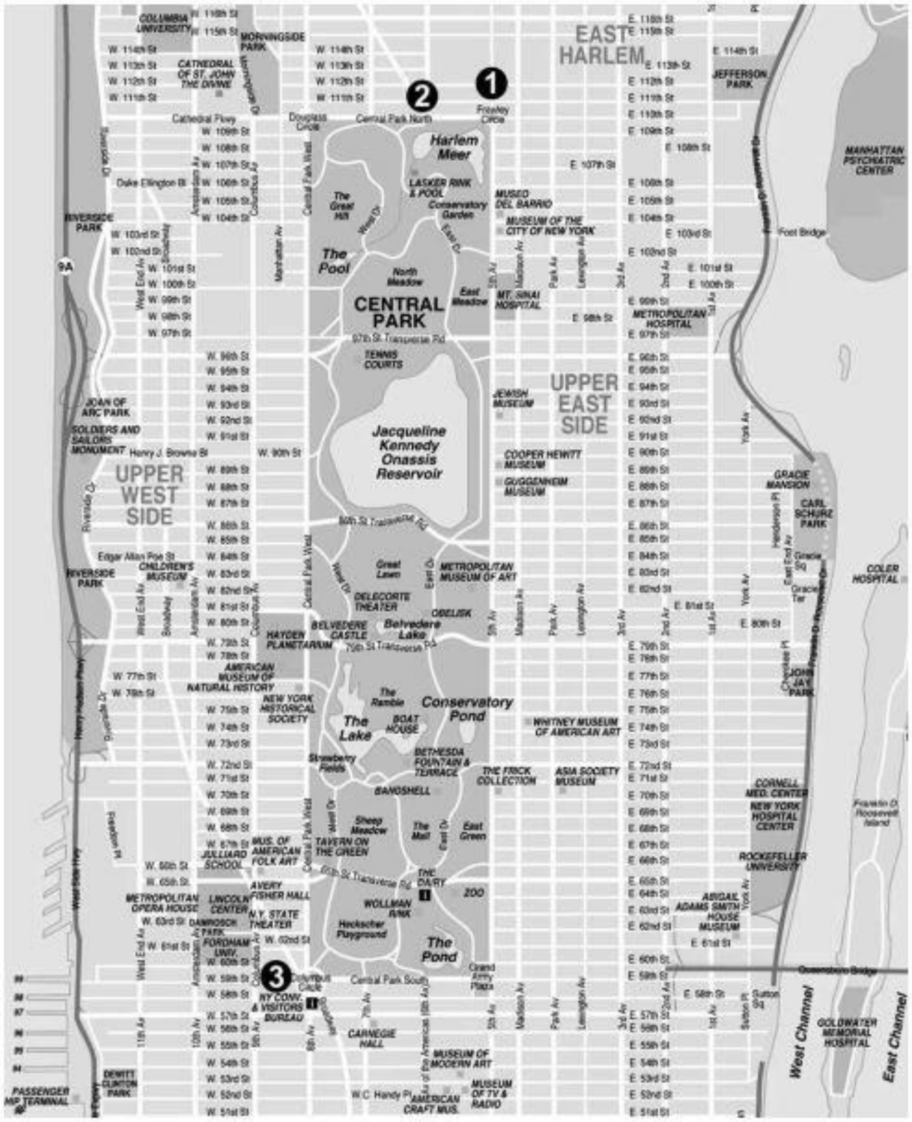


Figure 51 Manhattan map near Central Park, urban mobility strategy.(Google 2020)

.

The fact that the information included in the axial map (the only input to space syntax) has been limited is the source of most of the criticism discussed above (Xiao & Xiao, 2017). The employment of a topological basis and the rejection of essential city information (such as metric) offer significant practical and philosophical challenges. Although a simplified format and clear and precise illustration of the street network would have been necessary in the early days of space syntax, when computing resources were scarce, it is possible that a more comprehensive analysis based on a better support would be useful today to understand the 's*ocial logic of space*' (Bundckok, 2004). The effectiveness of the axial map "*does not preclude a more sophisticated kind of analysis... from yielding even better results*" (B. Hillier et al., 1993). Novel computer tools are being developed at a rapid rate to allow for a thorough investigation of urban texture. In metropolitan settings, raster digital elevation models may be used to calculate a variety of important metrics such as visibility, trip time, and cumulative distance. This enables for a fast examination of space's metric and topological features.

7. Conclusion

Space Syntax is a set of ideas and methodologies for modeling and evaluating cities that use space as the primary generator. One significant advantage of this method is that it is underpinned by a strong social theory of space. Space syntax theory, established in the 1980s and the 1970s by Bill Hillier and his colleagues (B. Hillier & Hanson, 1989), describes the logic of society through its manifestation in spatial systems: how the way spaces are placed together, or the arrangement of space, relates specifically with how people perceive, move through, and use spatial structures of any kind, ranging from small spaces to large-scale public spaces (Penn, 2003). This appears to be a common sense approach to comprehending cities, but it has been missed in many urban theories, particularly in recent decades, when fast expansion and urbanization have necessitated new approaches to dealing with cities. The configuration-function link, or, in broader words, the space-society paradigm, has an immediate impact on design and planning. Because spatial configuration and urban functions are inextricably linked, spatial configuration analysis is a valuable tool for creating, structuring, sustaining, and altering urban functions. Based on this premise, which is highly supported by research, a number of approaches and modeling tools for studying spatial configuration have been created (Penn et al., 1998)**.** These strategies are primarily based on extremely basic human behavior ideas like as mobility, visual perception, and human employment, which directly relate physical space with humans. To establish a network of spatial elements, the models employ simple geometrical properties such as lines of sight and movement or visual fields of awareness. This network is then converted into a pattern of relationships, or a graph representation, which may be statistically examined to identify the relative importance that each space plays in the overall or component configuration of the system. Because of the nature of the elements utilized in simulation, any spatial configuration study using space syntactic approaches is directly related to how the urban system operates. This simply converts a collection of analytical spatial models into an usable approach for evaluating the distribution of movement, activity, and behavior within the system (Endibargh, 2012a)**.** These approaches are simple in nature, but they have the potential to grow more complicated by integrating spatial arrangement with other spatial properties such as movement, land use, density, social interactions, and almost any other spatial property of the city. The model is also multi-scalar since the configuration may be examined in multiple settings, and it is multi-disciplinary because spatial qualities are imbedded in numerous fields. The product is an analytical tool that may be used to better comprehend complicated spatial systems and design them utilizing analytical evidence.

CHAPTER FIVE

DATA COLLECTION TOOL

1. Introduction

The process of gathering quantitative and qualitative information on certain variables with the goal of analyzing results or gaining actionable insights is known as data collection. A defined method is required for good data collecting to guarantee that the data we collect is clean, consistent, and dependable. Yet, establishing that procedure might be difficult. It entails assessing the objectives, determining the data requirements, deciding on a data gathering strategy, and lastly constructing a data collection plan that summarizes the most significant components of the research program. The technique used is determined by many factors (survey theme, the timing of data delivery, difficulty in locating the required information, type of respondents involved, budget, etc.) and is usually made during the design phase of the process because the technique influences how data is collected as well as the design of the survey.

visualizing spatial relationships becomes undoubtedly crucial when it comes to comparing these results with empirical data on socioeconomic activities. Connecting the results from space syntax investigation with primary and secondary data of human activities can provide new and useful knowledge considering society–space relationship in the field of quantitative research, the emphasis is on defining facts, and reality is objective because immutable. The data in the methodological approach originate from measurements. The data is analyzed using numerical comparisons and statistical deductions, and the results are presented in the form of statistical analyses. Fieldwork, online research, also, cross-sectional research, and experimental research can all be used to collect data. In this part, we will offer a method for collecting quantitative data from pedestrians, which will then be employed in a statistical study. The data collected for our research work is represented graphically above and statistically in the coming sections. This chapter describes field observations on pedestrian movement and static activities in an urban environment. Field visits are often organized prior to planning and performing observations to gain a basic understanding of the site conditions and surroundings, designating essential functionality or land uses in the layout and making first judgments on where to assign observation areas. Consistent and well-structured on-site observations are often meant to quantify real movement and occupational behavior and verify spatial expectations in order to develop a quantitative description of movement behavior in the public sphere. In the parts that follow, we will go through the observation methods and how they are carried out in the study. Observations are often assigned to specific places to guarantee complete coverage of mobility and occupation activities within target regions. The approaches mentioned can only serve as guidelines; specific considerations can be made for the unique characteristics of each study or design project.

2. Pedestrian data collection

2. 1 Pedestrian count requirements

A complete pedestrian census should encompass all midblock sites and crossings in the city to assess overall pedestrian traffic patterns for a variety of purposes. When manpower and funding are few, the census may be limited to midblock areas or major pedestrian routes. More limited pedestrian counts should be conducted at junctions where pedestrian accidents exceed four per year19 or where pedestrian movement causes other traffic difficulties; at mid-block sites with high pedestrian flows; or in areas or locations prescribed by the count's objective(Marshall, 2004).

The distorting effects of anomalous seasonal and temporal variables should be avoided in order to present an accurate picture of pedestrian traffic. When excessively hot or cold weather keeps people off the streets or out of the Downtown entirely, the count should not be undertaken. Holidays, special events such as parades, and extraordinary disruptions such as fires and catastrophic accidents should also be avoided. The hours for the count are maybe the most important issue. The count should occur between the hours of 6 a.m. and 7 p.m. in all cases; at a minimum, it should encompass the time from midday to 6 p.m., when peak volumes typically occur. While some counts have been done for as little as six hours, nine to 12-hour counts would provide more reliable data, especially when high pedestrian volumes are predicted throughout the day(Boeing, 2017).

Other distorting factors may be present at the counting places, which should be avoided if feasible; in any case, the distortions should be recorded by the counter. Street or sidewalk repairs and new construction, as well as high activity at truck loading zones and delivery sites, will divert pedestrian traffic off typical routes. Large numbers of pedestrians approaching and exiting adjacent significant pedestrian traffic generators, such as large department shops, will not be recorded if a counting location is located between two nearby major pedestrian traffic generators. In such cases, the count station must be relocated or a second may be added (Boeing, 2017).

A complete pedestrian count, linked to a study of pedestrian trip purpose, can help to find regions of maximal pedestrian activity where exclusive pedestrian routes or areas would be of greatest advantage, and indicate their level of use following construction. It can also illustrate how far such routes or regions would redirect pedestrian traffic from neighboring or nearby sidewalks, minimizing friction with motor traffic even further.

3. Gate count observation

Space Syntax Observations are a collection of approaches for observing movement flows and patterns of space utilization in large buildings or metropolitan settings. These techniques were created expressly for Space Syntax Research, however, they are similar to approaches used in other sciences and fields. To develop space syntax analysis, a variety of data collection tools (e.g., surveys and land use maps, time-lapse photography, questionnaires, interviews, and so on) are best appropriate for our research issue. There are several approaches for conducting social behavior research. Some of these will be discussed in the following sections.

3.1 Background

The pedestrian count is a basic, low-cost method of measuring the amount and direction of foot traffic in the city over time and by place. As such, it gives quantitative data to assess the necessity for and efficacy of different pedestrian planning strategies in specific locations and at certain times (Vaugan, 2005). The focus of this section is thus on providing a helpful approach known as gate count observation, which has proved its use in obtaining quantitative data by direct observation; the development of this methodology has been driven by academic interest. Initially, flow count studies focused on capturing pedestrian volume simply using a simple head count' divided by direction of travel along the pavement, but due to its labor-intensive nature, most pedestrian flow data that may be relevant for modeling is lost. As a result, the applicability of such data is restricted (Vaugan, 2005). A systematic research technique for collecting flow data would enable datasets to be pooled for academic study, assisting in improving the existing data-poor nature of pedestrian volume research.

Space syntax (2002), utilized a similar flow counting procedure to that used by (Dasyles& Duxbury, 2001). Nevertheless, they include pedestrian type in their data collection, allowing the pavement population to be studied by pedestrian type. A recent analysis of activity outside the South Kensington Tube station conducted by space syntax (2002) splits pedestrians into suits and casuals. This provides a more disaggregate image of pedestrian flow, with commercial personnel traveling south and students and gallery goers walking north.

Dasyles& Duxbury, (2001) counted six places along two green belt routes in Indianapolis, Indiana, using hand counts for flow data. A trial study's data categories comprised the number of users, method of usage, group size, gender, and race of route users. Make use of speed and direction of travel. Depending on the previously recorded flow levels, each trial employed one or two counters. This data combination generated issues for the counters. The volume was considered to be too big to adequately collect all of the aforementioned information, thus the race and direction variables were deleted as they were regarded as least important to the study.

The researchers report that even with the best categories eliminated, data collection during peak hours was problematic at most sites (Dasyles& Duxbury, 2001). Our findings indicate that a uniform dataset for pedestrian flow observations with more than the bare minimum of information is unlikely to be accepted since it is too time-consuming to gather and the added strain on observers is likely to create new sources of inaccuracy

Observers should consider what is significant in relation to their research topic, as well as how the site is utilized while designing the research. Students should also be aware that Fridays, Saturdays, and Sundays differ in the United Kingdom. Hence, before they begin their study, they should consider how frequently and when they should perform observations, as well as if weekends are relevant at all (Dasyles& Duxbury, 200. Data are collections of information. Normally, in spatial syntax, data are used to grasp and assess the relationship between society and its space. Data can take any form, for instance, Data can take any form, we can cite; interview transcripts and field notes. The type of data collected influences the type of analysis that can be used to interpret it. Academic disciplines develop research methods accordingly (Barker, 1980).

4. Considering where the data comes from.

Unless you acquired your data yourself, you may be misled about its nature until you conduct some investigation to determine where the data originated from, how it was obtained, what it was collected for, and how the data was coded. The answers to these questions will help you determine how relevant the dataset will be for your own study(Barker, 1980).

5. Static snapshots

Static snapshots are typically used to document the use pattern of spaces within buildings or public spaces in an urban environment. The approach is excellent for contrasting static actions (such as standing and sitting) with movement. We can highlight the patterns of space utilization in a region and identify the spots where more potential contact occurs naturally by recording and mapping these activities over time. In general, snapshots are similar to an image taken from above that depicts one moment of activity mapped into the floor layout. These are often taken at regular times throughout the day to offer an objective assessment of the day's invariant patterns of activity as well as varied and unusual behavior (Vaugan, 2005).

To perform snapshots, we predefine locations that may be conveniently seen and positions from which an observer can maximize visual exposure to the observed field of study while minimizing his/her own visibility to users. We utilize a large-scale (1:50) floor layout to record categories and activities (sitting, standing, moving, conversing) for five minutes at regular intervals throughout the day (see figure 87 for an example on snapshots). Additional peculiarities related to weather, unusual behavioral patterns, IT use, or site settings might be noted in written language on observation sheets.

Figure 52 Depicts movement traces and static activities on a 1:50 scale plan of the target region. Source: (Vaugan, 2005)

6. Movement traces

According to Grajewski & (Vaughan, 2001). movement traces allow for the tracking and mapping of collective flow dynamics within a specific region. It aids in identifying movement patterns and where individuals are most likely to arrive and depart the area (see figure 88). Observers may also be able to identify islands with no documented movement traffic. Target regions, like snapshots, are typically chosen to have a convex layout that is easy to notice. The observers place themselves in areas that allow them to see the layout as clearly as possible and record movement for 5 minutes at various time intervals throughout the day. Kids are invited to indicate different categories on the layout with colored markers (Vaugan, 2005). On-site observations are often used to scientifically track and record human behavior. These are primarily intended to put to the test the spatial models we developed earlier based on visual configurations of urban layouts. When there is a correlation between observation and space, it validates and supports our notions about the function of spatial visibility and access in making particular settings more hostile to human encounter and interaction. If there is less correlation, more research is required to identify any external attractors or outliers in the environment (Reynaud et al., 2019).

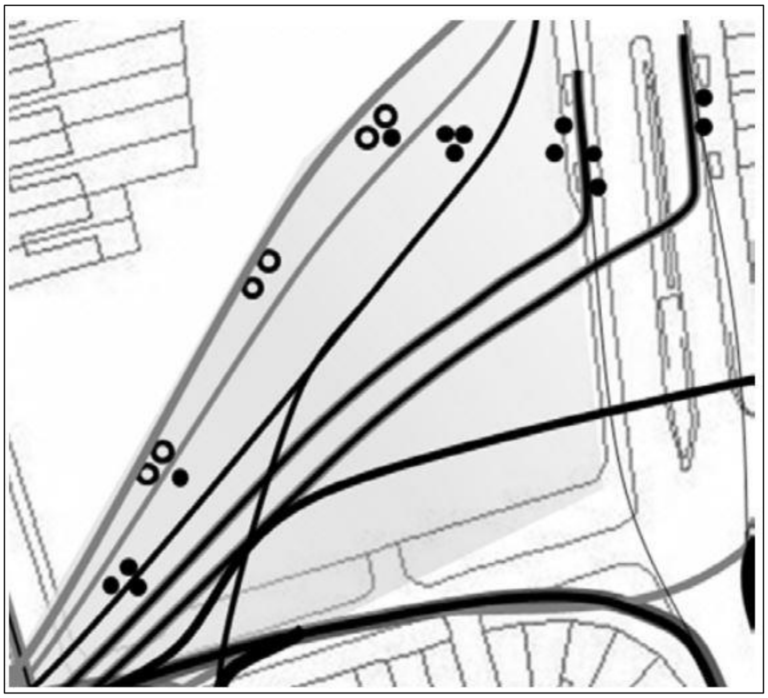


Figure 53 Movement traces and certain static patterns on a 1:50 scale plan of an urban region
Source: Space Syntax Limited, 2007.

7. Traces (People-Following)

According to Grajewski & Vaughan, (2001), Tracing people is an essential approach for observing movement flows that are 'distributed' from a specified movement distributor, such as a railway station, a shopping mall, or building entrances. It may be employed in both urban and architectural settings. The usage of this approach may be used to study three separate issues: 1) movement patterns from a certain site; 2) connection of one route to other routes; and 3) average distance individuals walk from one spot to another (e.g. to study the catchment area). To begin tracing, we utilize a plan of the whole region of interest. In metropolitan areas, it is preferable to design the plan such that the pick-up location is in the center.

To eliminate bias in reading movement behavior, observers should pick up people at random as they begin a journey from a predetermined place of beginning and trace their course. The tracking might be halted when persons leave the area of interest, arrive at a predetermined location, or after a set length of time (e.g. ten minutes) (Vaugan, 2005).

It is critical to maintain discretion during this procedure; individuals should not become aware that they are being followed. It is usually a good idea to account for a variety of persons (age, gender, and other areas of interest) and take detailed notes for each trace. When comparing movement behavior from a certain point of origin in a layout, tracing is a highly useful tool (an entrance). It is typically used to show visual comparisons of spatial analysis (VGA) and movement traces (see figure 6.7) (Reynaud et al., 2019).

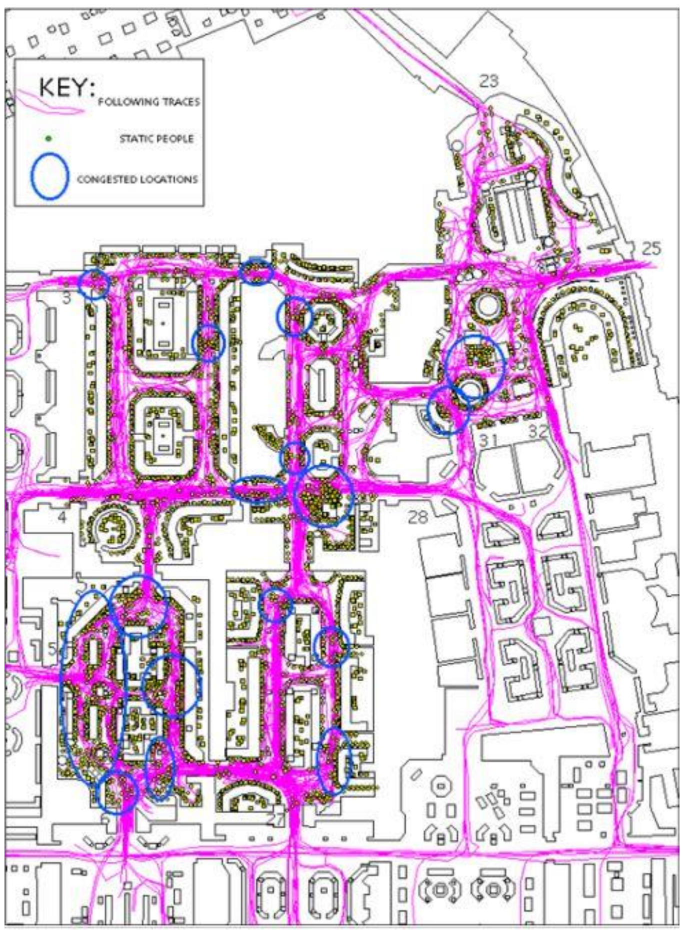


Figure 54 Movement traces and static activities are drawn on a 1:50 plan of the target area.
Source: (Vaugan, 2005)

8. Directional split

8.1 Applicability

This strategy is only useful for observing moving individuals or vehicles. It is commonly used in urban settings, but it may also be used to describe the inside of places or structures (Barker, 1980).

The goal of this approach is to record the split of movement flows at a junction (in absolute numbers and percentages). This might include how pedestrian and vehicular traffic separate at a street intersection, or how passengers split as they exit a station. The procedure entails drawing a diagram of the junction and calculating all of the different directions in which the movement may split. They should be labeled A, B, C, and so on. A person or vehicle should be picked at random among those approaching the crossroads and followed until it is clear which of the various destinations they are heading for (Barker, 1980).

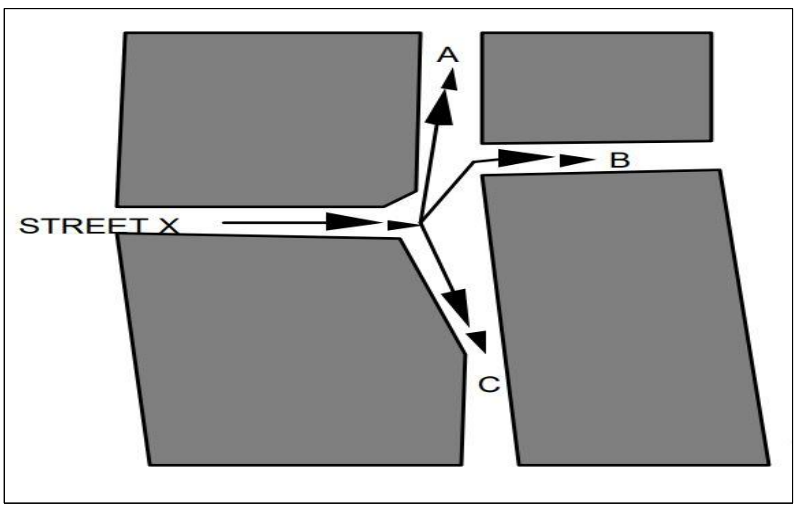


Figure 55 ThepossibledestinationsfromStreetXareA, B,and C.
Source: (Vaugan, 2005).

The number of persons or vehicles entering a destination place can be recorded on a tally sheet, or (for greater accuracy) straight onto an expanded plan, with a separate square for each split point.

To avoid bias in the observations, pick a person or vehicle that is some distance away from the junction. For example, the majority of individuals exiting a particular station exits on the left are likely to turn left again. As a result, pick people before it is evident whether they are going left or right (Vaugan, 2005). A minimum of 100 individuals or cars should be tracked through the intersection. If various categories are observed (for example, males and women, or tourists and suits,' then 100 persons should be tracked in each group. A typical count of the number of individuals traveling through the junction should be performed at the beginning and conclusion of the observations, with a separate count for those coming out of the junction and one for those coming in (Vaugan, 2005). This method might be performed numerous times around the place of interest to construct a picture of how the movement separates at each successive intersection. Because it takes a long time to cover a single junction, it is best to deploy numerous observers at several junctions at the same time. This allows the observations to be performed in a single time frame. People's behavior may vary if a later observation is made in a different time period.

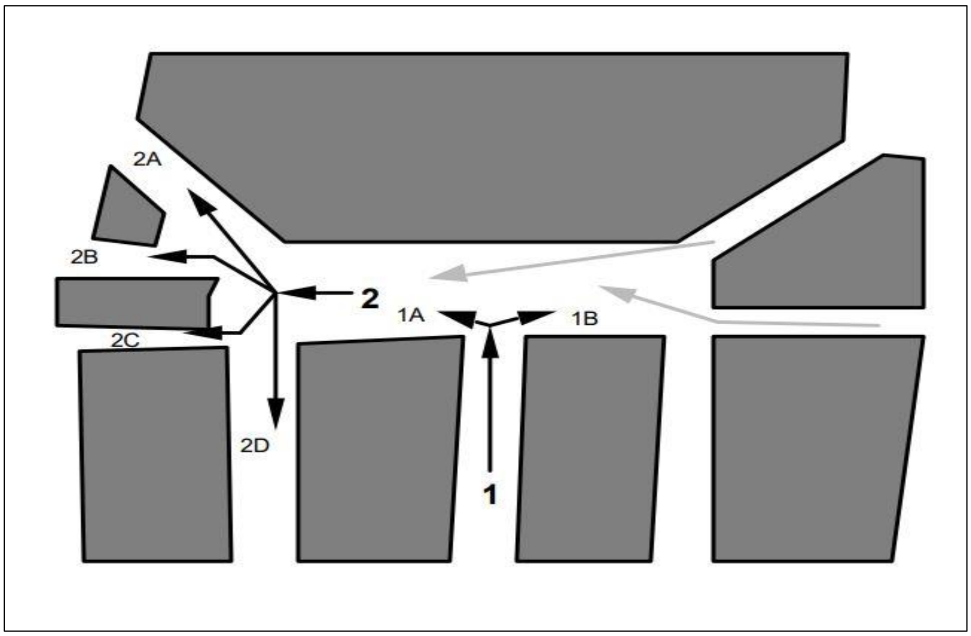


Figure 56 In a complicated circumstance, such as this entry point into a square numerous split observation locations may be required. The difficulty at location 2 is that it gets movement from streets other than the initial street 1; therefore, a true image of the final distribution from the starting street is no longer feasible. Source: (Vaugan, 2005).

This procedure might be repeated several times around the point of interest to build a picture of how the movement divides at each subsequent junction. Because covering a single junction takes a long time, it is ideal to deploy several observers at multiple intersections at the same time. As a result, the observations may be completed in a single time period. If a later observation is taken in a different time period, people's behavior may change (Vaugan, 2005). Follow a person on foot to determine their destination, or divide the operation into smaller junctions. The flow, however, will be confused by people or cars entering from other directions at each successive junction, and hence will not provide an accurate representation of the distribution from the original beginning point. The most important idea is to use new persons for the succeeding rounds to increase cross-checking and decrease boredom (Barker, 1980).

9. Conclusion

We observe to see how much we can learn about the environment without considering people's intentions. If you question each person in his or her city about their pattern of travel, he or she is likely to respond in terms of journey reasons. Yet, since cities are so huge, dense, and densely inhabited, the objectives of persons traveling through them do not represent the whole of activity contained therein. Their combined action results in a pattern of usage and movement that is independent of individual intents. In this type of circumstance, seeing what happens allows you to glean information about the objective features of the constructed environment. A survey of the physical make-up of the region in issue is an essential and beneficial way of describing the prevailing circumstances in an urban area. This is, in fact, a long-used research method across disciplines that may be especially effective for conveying the researcher's intuitions. The movement map is the most typical type of this sort of depiction. Modeling pedestrian movement flow methods are heavily reliant on the data provided as model input. In general, the model's aggregate and degree of detail are tightly associated, which means that detailed prediction at the individual level needs precise data about the individuals and their surroundings (Van de Voorde et al. 2011). Observations may be utilized to provide numerical data on urban space utilization and mobility, which can then be connected with geographical characteristics. The most significant distinction is between integration and encounters (observed use and movement). We may utilize the findings of observational studies to investigate social factors such as crime trends and adult and child behavior. This is due to the fact that integration is an independent measure - the integration value of space can create people (or shops or other functional variables), but the presence of additional people cannot make space more integrated. Controlling the architectural variable affects the kind of questions that may be answered by having a systematic means of expressing space. We may employ observational data to more objectively assess and depict our intuitions as we construct and seek answers to space-related problems. The grid's layout results in a stable structure of occupation and usage, that can be dense or sparse, localized or global, predictable or unpredictable, based on the pattern of spaces that mixes occupants and outsiders to varying degrees. The encounter field is created by the layout of the urban grid. The form of the urban grid and the placement of the buildings within it produce a natural background pattern of movement and space utilization. We know this through the sum total of using research and observational methodologies in a way that gives us with an objective image of the reality 'on the ground'. The essential discoveries that will be given during the coming chapter are the result of theoretical/quantitative models of spatial analysis and observational representations, both graphical and statistical. To examine the shifting relationship between the spatial and functional centrality structures in Constantine city, a review of the data collection tool was extended. To allow us to compute the observed data along the selected streets.

CHAPTER SIX

THE CASE STUDY: THE OLD AND THE NEW TOWN OF CONSTANTINE CITY

1. Introduction

Every city is born, grows and transforms in time and space, through its size, its physiognomy and its functions. It is like an increasingly complex organism. History shows us that the city of Constantine, which has seen many civilizations, has managed to keep a certain image and a certain identity. Nevertheless, the changes operated now for nearly two centuries prove to be more important and more decisive to its urban space. The urban space which was characterized, formerly, by its organic form is subject to new transformations which aimed to air the urban fabric considered dense. Faced with the housing crisis that followed the post-independence policy where all efforts were directed to the industry sector, the state launched several projects of neighborhoods comprising several hundred, even thousands of housing. It is in fact a pure reproduction of the big complexes that were built in Europe and where the quantitative aspect was more important than the qualitative one without any real care for the living environment. The ZHUNs are a perfect example of what is being done with this urban policy designed according to purely functional principles. Ali Mendjeli, the new town of Constantine, embodies this new approach to the production of space, previously regulated by an obsession with performance. Its spatial framework is structured primarily by the collective building which ostentatiously stands out to define the architectural character of these new urban zones.

The short but winding history of the new town is an illustration of the paradoxes of urban planning and public policies in Algeria. A product of the voluntarism of local public authorities, Ali Mendjeli remained without legal status for many years. it was finally elevated to the rank of a new town, but not without having experienced a process of trial and error and improvisation. A narrow and sectoral vision of the new city, responding only to a quantitative need for the various actors, would inevitably lead to a city devoid of all the requirements of a harmonious life that every inhabitant hopes for. The latter, having been built with the intention of reducing the congestion of Constantine, as an alternative to the development of the urban bangs, and as an instrument of balanced regional development, is faced with difficulties that it must overcome. A wide comparison between a New Town and older town may be undertaken to quantify the apparent difference between them . Prior research has found that successful, historically developed communities share a number of common geographical traits (Endibargh, 1998). These traits are crucial to understand since the age of certain older cities is related to their capacity to survive periods of transition and adapt to diverse environments. A sample of New Town and older town were chosen for this study. The study concentrated on the urban structure of ancient and new towns, including spatial organization, land use distribution, centrality, and mobility patterns, all of which characterize a town's physical, social, economic, and environmental aspects.

2. The geographical location of Constantine City

The wilaya of Constantine is located in eastern Algeria where it occupies a central position. It is surrounded by the wilayas of Skikda to the north east, Mila to the west, Oum El Bouaghi to the south and Guelma to the east. With a population of one million inhabitants, it covers an area of 2297 km2. The wilaya of Constantine is the node through which the various communication routes pass. Consequently, it is the place of convergence and passage of people and goods. These facts give it the status of a regional capital. Its influence goes beyond the limits of the eastern region of the country and extends to several parts of the country and even beyond.

The city, which has been in existence for more than 25 centuries, is built on a fabulous site, namely the rock. The city is crossed by the oued du Rhumel which divides it into two (2) distinct parts. The gorges that bear the name of the wadi can reach a height of nearly 200m. The site of the city of Constantine changes in type according to the part on which one is. In the south-east, there is the rock on which the medina of Constantine is built. It is surrounded by rocky escarpments. The hills are characterized by fairly steep slopes and unstable terrain. These sites are the preferred location for most of the colonial residential cities such as Bellevue.

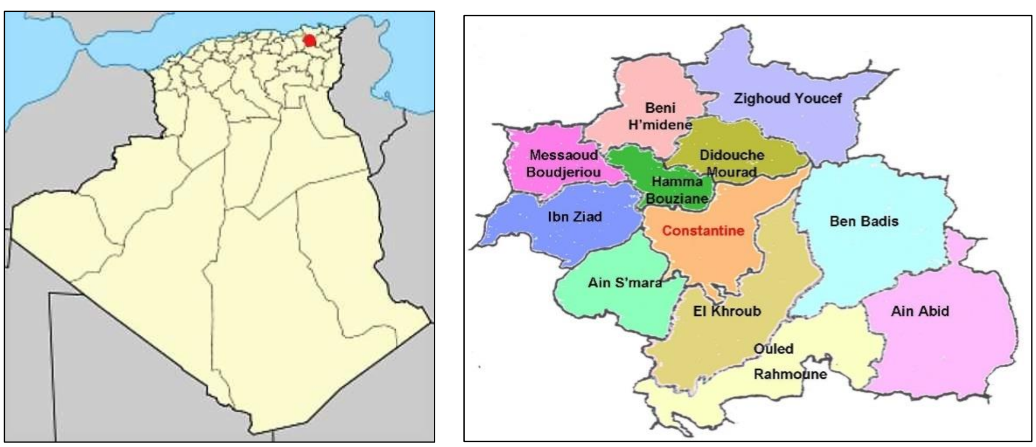


Figure 57 Left: The location of Constantine City in the Algerian map.
Right: The Wilaya of the Constantine and the municipalities that depend on it.
Source: (*Wilaya de Constantine*, n.d.)

3. Urban development of the city of Constantine

According to (Samali & Lekehal, 2017), urban development in Constantine can be divided into three periods:

3.1 Pre-colonial phase

With a history of more than 2500 years, the city of Constantine has seen several civilizations pass through it, from the Phoenician era to the French colonization in 1837. Its location in the interior of the country, with a central position in eastern Algeria, has long made it a strategic place for various exchanges. It is a hub of the region. Constantine at that time occupied a rocky site called the Rock. This trapezoidal site has all the aspects of a natural fortress. This gives it a very natural defensive system. The actual old town of Constantine is located on a rocky plateau of nearly 42 hectares and at an altitude of 649m. This remarkable site is surrounded by canyons and ramparts. It gives it a typical image "its configuration of an eagle's nest perched on a rock gives it a world-famous image "(Côte, 2006). The urban space of this city is similar to that of other medinas and is characterized by vaulted passages, setbacks, and dead ends. The narrowness and sharpness of the streets and alleys is other characteristics of the urban fabric of the medina of Constantine. The habitat is essentially made up of houses with patios and most often with sloping tile roofs where they sometimes group several families. The medina of Constantine from the pre-colonial period has always kept its limits in the rock. This is partly due to the aspect of its site. Indeed, this site, considered difficult to access, has a good defensive system. Of the four doors that the city has, that of Bab El Oued which is located in the southwest is the most important (Samali & Lekehal, 2017).

3.2 Colonial phase

Until the Ottoman period, the city of Constantine did not experience any major upheavals. It was during the first years of colonization that the first transformations of the urban fabric were carried out. In the beginning, it was a partial renovation of a part in order to adapt it to the new occupants to take then a more important scale.

Two (2) cities were built for the needs of the colonizers, one military, where the court and other military facilities were built, and the other of an administrative nature. Within the framework of the Haussmannian breakthrough project, three (3) breakthroughs were made in the early 1850s, the first of which was the Rue de France. This led to the demolition of several old buildings.

This first period, when the colonizers tried to make their mark for a better settlement, was followed by important population growth. In addition to the local population, several settlers arrived from all over Europe. This led the authorities to consider extending the town outside the boundaries of the rock by building several communication structures such as bridges and roads.

In the beginning, the expansion of the city was done in two directions. To the south through Breach Square and to the northeast through the Al Kantara Bridge. In this perspective of spatial extension, several colonial districts and suburbs were built to meet the housing needs of the newcomers from elsewhere: "The colonization, which needed space, envisaged creating a doublet city, spatially separated from the traditional city... "(Côte, 2006).

New districts such as Coudiat, which includes administrative facilities and apartment buildings, have been created. The junction between the old city and the beginning of the colonial city is ensured via the Place de la Brèche. It was a place for walking and recreation. Other residential districts such as Bellevue, S. Mabrouk, and the Lamy suburb grew on new land (Samali & Lekehal, 2017).

These neighborhoods, which were intended for settlers, mostly adopted urban planning principles imported from Western countries that were foreign to the city up to that time. They were based on a checkerboard plan and did not take into account the topography of the land. The first street trees were planted all over the streets and boulevards, like those in St Jean.

A little later, a new form of spatial expansion appeared, especially linked to employment and population growth. From the 1930s onwards, the influx of rural populations to the cities, attracted by new sources of employment, led to the over-densification of the traditional city and the spontaneous creation of peripheral popular suburbs. The end of the 1950s saw the launch of the Constantine plan, which aimed to build large apartment blocks. The Cité Ciloc and the Cité de Loucif are perfect examples of this. These were buildings that generally exceeded eight floors (Samali & Lekehal, 2017)..

3.3 The post-colonial phase

From the first years of independence, the Algerian state's policy was more oriented toward the economic sector and in a particular industry. Many agricultural lands were sacrificed for the establishment of production units. Several hundred hectares were consumed by these sites. This has led to real problems, particularly in terms of the exodus of people in search of work and the pollution generated by these units.

Also, this expansion has generated multiple complications for the new extensions of the city. This expansion was first done in the extension of the European residential areas and then extended to the surroundings of the industrial sites. The housing deficit due to population growth and rural exodus is significant. This has given rise to various forms of unplanned housing, with all the consequences that this has entailed.

In order to meet this increasingly urgent need for housing, the state was obliged to revive the housing sector. The periphery was invaded by numerous collective housing districts built in prefabrication systems. This system, imported from Western countries, allowed for the mass production of housing. As for individual housing, it developed in an anarchic manner. This urbanization process accelerated and developed to the detriment of agricultural land through the creation of new urban housing zones (ZHUN). These ZHUNs were much more neighborhoods intended for the simple function of housing. The living environment and urban life were not a priority for the various decision-makers. On the other hand, and despite the social status attributed to the Z.H.U.N., these housing estates have brought together very diverse populations in terms of their culture of origin and their socio-cultural levels. This is why all social categories are sometimes found in the same block, which makes promiscuity extremely difficult. More worrying are the incidences of the transfers of the population to these cities following the demolition operations of the slums.

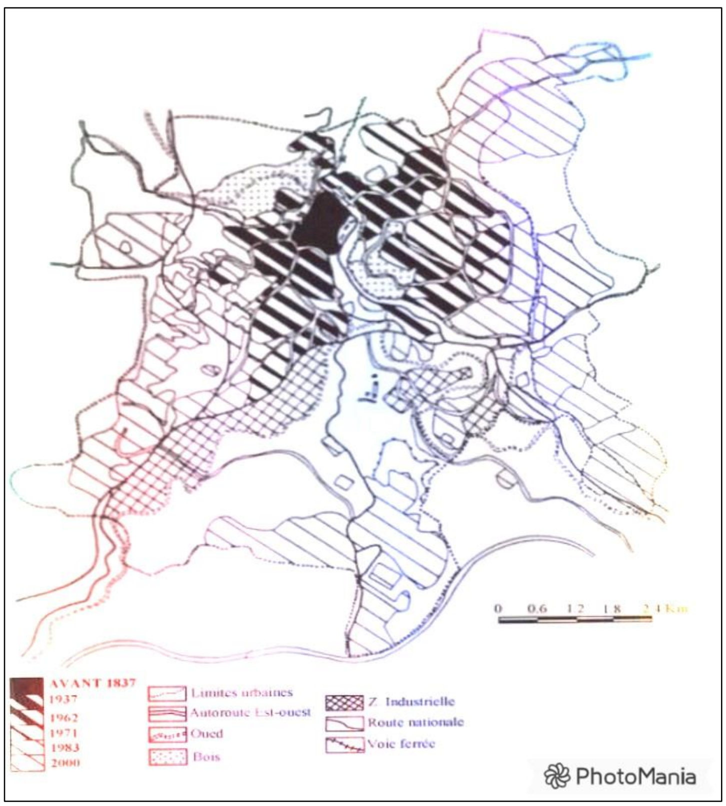


Figure 58 The evolution of the city of Constantine from 1937 to 2000.
Source: URBACO, cited in (Samali & Lekehal, 2017).

4. The new town Ali Mendjeli

4.1 The birth of the new settlement

new towns are generally born of voluntary action. They are most often the result of a political decision. According to Côte, (2006), they can be of two types: new cities are designed to recompose the regional territory, to create a training pole in neglected areas, to rebalance the territory. – or designed to relieve congestion in an urban metropolis. The new town Ali Mendjeli is part of the second example of new cities. It was built in order to solve the various problems faced by the city of Constantine particularly housing problems. the idea of creating a new city became more than necessary. Thus, the decongestion of the mother city and other problems related to its extension were to be more or less mastered (Samali & Lekehal, 2017).

The city's south side offers the best options for the establishment of this new town. In this regard, the Ain El Bey plateau offered the best guarantees and benefits for such a project. This terrain's chosen themes are:

The site is geologically stable. It has good constructability and can accommodate multi-story buildings; - the land has little agricultural value; - the land status of the land, which is almost entirely owned by the state; - a large land base that exceeds 3,000 hectares; - the topography of the site, which does not show strong pentagram variations. The installation site is close to essential facilities and communication routes (Samali & Lekehal, 2017).

The new town Ali Mendjeli was created within the framework of the master urban plan (PUD) of the Constantine grouping on 28/01/1988. This is confirmed and approved within the framework of the PDAU by the executive decree n° 98/83 of 25/02/1998.

4.2 Situation and site of the New City Ali Mendjeli

The New City Ali Mendjeli (the map above) is located on the plateau of Ain Bey. It is located about fifteen kilometers south of the city of Constantine, about twelve kilometers west of the city of Khroub, and about ten kilometers east of Ain Smara. Its average altitude is 800 m. It is located on a vast and virgin site. Its land base straddles the town of Khroub (1002 ha) and that of Ain Smara (498 ha).

This city is a single block of 1,500 hectares. It does not have large slopes because the slopes are small and only in some areas they rise to 10%. The soils are of good consistency (clays and limestone formations in sub horizontal position). Geotechnical studies have concluded that the land has a good bearing capacity and that there are no landslides. As for climatic conditions, the new town, because of its site, built on a bare plateau, without natural protection, experiences cold and rainy winters and hot and dry summers. It is exposed to all winds since it is swept in winter by the northern currents which are loaded with rain and in summer by the hot winds (sirocco). This exposure considerably reduces humidity problems. On the land front, the authorities already had nearly 1,200 hectares (state land) and they bought the other 300 hectares from private individuals. These lands did not have high agricultural potential.

According to Kassah, (2007), the new town Ali Mendjeli occupies a rather exceptional site compared to the city of Constantine since it enjoys a remarkable position for the following reasons:

-In the North - East, is located the international airport "Mohamed Boudiaf" which moreover is a

zone and therefore forbidden to any construction.

-The wilaya road N° 101 which connects the city of Ain Smara to that of Khroub is a transversal road that crosses and divides the new city into two large parts north and south.

-The national road No. 79 which passes nearby connects the new city to that of Constantine.

-The national highway East-West (under construction) passes north of the city.

In short, this site has several favorable assets at the local, regional, and national levels.

Figure 59 Ali Mendjeli geographical situation.
Source: (*Google Maps*, n.d.)

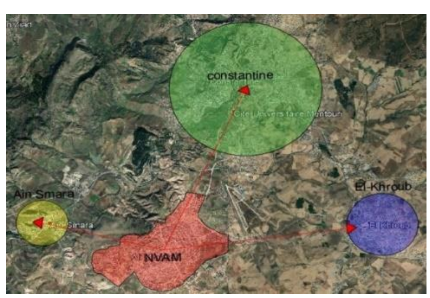


Figure 60   Location map of the city Ali Mendjeli .
Source : Google Earth and (Cherif, 2021)

4.3 The configuration of the w town Ali Mendjeli

The new town Ali Mendjeli was created in order to solve the housing problems that were acute and insistent in the city of Constantine and its urban grouping. This new nucleus of settlement would contribute to a better spatial distribution of the population. The realization of this new town was not carried out in easy conditions of enthusiasm and long-term action. It has been a process characterized by periods of rapid progress but also by pauses at the different levels required for its realization. The new city is designed in its entirety to be raised to the rank of large cities. To achieve this, a series of facilities and various activity and leisure zones are planned to accompany the housing project. These facilities are planned for a city that must house nearly 300,000 inhabitants. They are intended to be the essential elements for the creation of a real dynamic of the new city (Samali & Lekehal, 2017)

The design of the new city Ali Mendjeli responds to a principle of hierarchical organization. The principles that governed the modern movement are very well expressed by the designers, with the clear separation of different functions. The city is divided into five (5) large neighborhoods, which in turn are divided into four (4) neighborhood units (UV) for each neighborhood.

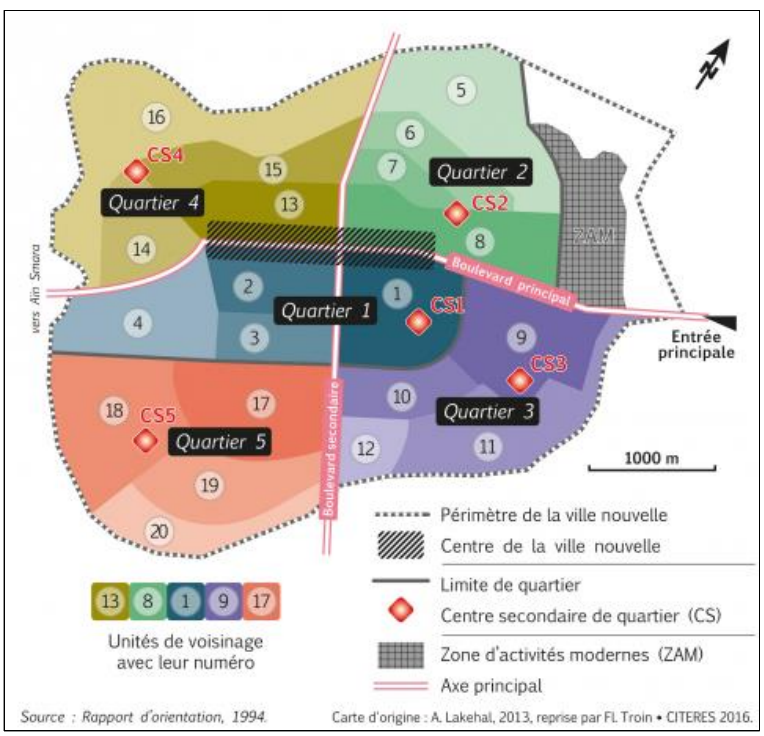


Figure 61 1994 master plan for the new city of Ali Mendjeli.
Source: (Lakehal, 2015)

4.4 The structure of the new town Ali Mendjeli

For the project of this new city two particularly important considerations guided him: the first is the uncertainty relative to its economic profile and its vocation as for the second it holds with the fact that our society, in full mutation, is difficult to know, to determine. In addition, studies on new cities in Algeria are non-existent. Apart from the land use standards relating to the various facilities and infrastructures of the ZHUNs, almost nothing has been established by the technical services (Kassah, 2007).

Therefore, the main objectives of the structure and function of the new city have been influenced by the need for flexibility in the functioning of the urban structure. This is made possible by its road network and land use strategy, which allow for a modification of the places and spaces reserved for activities and structural facilities. Considered as a structure with a set of alternatives for the location of future facilities and residential developments, it will allow and permit future modifications. In concrete terms, the proposed structure of the city has a fairly compact, compact form. It is the result of a road network that is influenced by the flat relief of the site. The circular shape of the road network allows for quick access to the various districts of the city. This urban structure is based on a hierarchical road system that serves the housing areas as well as the various equipment and activity areas, and above all it orders the city

Thus the main center of the city has a very elongated shape, very spread out. It is in fact the main boulevard which is of east - west direction. It is almost 5000 m long and 80 m wide. On a section of 1500 m, the traffic in both directions is separated by an esplanade. This main boulevard is intended to receive city-wide urban facilities. As for the secondary boulevard, it is 2345 m long and 50 ml wide. It intersects the main boulevard in the center of the city and connects the northern and southern parts of the city. The secondary centers are located all around the main center. They have a direct functional and spatial relationship thanks to their road network. They will be provided with facilities on a neighbourhood scale, including a set of public gardens. A 22-hectare urban park will be used for relaxation and walks, while an 80-hectare amusement and recreation park will provide entertainment. A multiple activity zone (Z.A.M) of 122 ha is located at the eastern entrance of the city (Kassah, 2007).

4.5 The spatial organization of the new city

Faced with these quantitative and qualitative challenges, the master plan took the form of neighborhoods represented in a very summary manner, in which different programs were to take place, the conception of the new city wanting to instill an approach in which daily life is punctuated by the use of school or cultural, social or health, sports or leisure, administrative or commercial facilities (a desire to integrate the facilities into the neighborhoods and to reflect on the places where community life is welcomed). The concern for the well-being of residents in their homes and environment is accompanied by a desire to provide each neighborhood with sufficient community services. The new city has taken the gamble of giving its inhabitants more than just housing, but also a living environment, thanks to a dense network of tertiary facilities and major projects crowned by the university and hospital centers, generating a socio-cultural and economic dynamic; the arrival of students and executives in large numbers can lead to the creation of new services and new activities . As retained in the policy plan and the master plan, the city has been devided into 5 neighborhoods comprising 20 neighborhood units (UVs).

From the preceding table, we can see that the city is divided into five major districts with an area of 1158.74 ha, while the city covers 1500 ha. The remaining 341.26 ha represent the land to be used for the amusement park, the cemetery and the multiple activity zone (ZAM).

Figure 62 Entrance of the new town Ali Mnedjeli.
Source: (*Ville Nouvelle de Constantine – Recherche Google*, n.d.)

Each neighborhood was in turn divided into 5 neighborhood units. These units can be considered the fundamental element of the city's spatial organization. The neighborhood unit is a set of housing units programmed, planned and structured for a given number of inhabitants. It has the necessary facilities and shops. In turn, the neighborhood unit is divided into 3 blocks or basic units. There are thus 60 blocks. This organization is characterized by great simplicity. Each neighborhood was in turn divided into 5 neighborhood units. These units can be considered the fundamental element of the city's spatial organization. The neighborhood unit is a set of housing units programmed, planned and structured for a given number of inhabitants. It has the necessary facilities and shops. In turn, the neighborhood unit is divided into 3 blocks or basic units. There are thus 60 blocks.

Tableau 2 Distribution of neighborhoods.
Source: URBACO- 1994 cited in (Kassah, 2007)

Quartier	Unités de voisinage	Superficie des U.V (ha)	%	Superficie des quartiers	%
01	01	75,04	06,48	227,18	19,61
	02	45,43	03,92		
	03	34,04	02,94		
	04	72,67	06,27		
02	05	86,32	07,45	219,75	18,96
	06	40,38	03,49		
	07	73,09	06,31		
	08	19,96	01,72		
03	09	69,54	06,00	227 ,22	19,61
	10	39,10	03,37		
	11	85,56	07,38		
	12	33,02	02,85		
04	13	58,45	05,04	183,31	15,82
	14	48,51	04,19		
	15	60,31	05,20		
	16	16,04	01,38		
05	17	82,03	07,08	301,28	26,00
	18	87,08	07,52		
	19	63,98	05,52		
	20	68,19	05,89		
Total		1158,74	100	1158,74	100

Each neighborhood was in turn divided into 5 neighborhood units. These units can be considered the fundamental element of the city's spatial organization. The neighborhood unit is a set of housing units programmed, planned and structured for a given number of inhabitants. It has the necessary facilities and shops. In turn, the neighborhood unit is divided into 3 blocks or basic units. There are thus 60 blocks. This organization is characterized by great simplicity. It is pyramid-shaped and responds above all to the requirements of programming, which in this case is very autonomous. City: 300,000 inhabitants Neighborhood group: 150,000 inhabitants Neighborhood: 30,000 to 48,000 inhabitants Neighborhood unit: 7,500 to 8,400 inhabitants Basic unit (block): 2,500 to 2,800 inhabitants Each neighbourhood has four neighbourhood units. Thus the city is divided into twenty (20) neighborhood units. They vary in size from 19.96 ha (U.V 08) to 120 ha (U.V 01) and in geometric shape. This heterogeneity in size and shape is the result of the topographical characteristics of the site, the number of inhabitants, housing and facilities (Kassah, 2007).

4.6 Ali mendjeli's land use plan (POS)

The Land Use Plan (*Plan d'occupation du Sol, POS*) was implemented in the early 1990s. It is the smallest scale of spatial planning. It details all construction and development operations and also provides for the location of the different types and densities of housing as well as the urban form. It also defines the location of green spaces, facilities, roads and delimits easement zones. Within this framework, the new town is concerned by nine (09) POS as shown on the table below n° (03). They cover an area of 1,232 ha. These POSs were developed in several phases. The above table reveals the existence of great differences in the surface areas of the SOPs, since they vary between 540 ha and 40 ha. Thus, the POS N°01, which includes 8 neighborhood units, occupies 43.83% of their total surface area, while the POS N°6, which concerns only one neighborhood unit, occupies only 3.25%.

-POS 01: occupies the main center and the north-eastern part of the city and it includes the following eight neighborhood units numbered 1-2-3-5-6-7-8-13. It has an area of 540 ha. It is undoubtedly the largest of them. This POS was the first one to be executed and this before its final approval, nor even the launching of the study of the P.D.A.U. This POS is central and it was indispensable for the birth of the city because it allowed: - the realization of the city's framework (different road networks) which is the basis of the project. - to provide the city with a set of basic facilities necessary for daily life. The risks of repulsion were present at the beginning of the city's construction. - to house the greatest number of inhabitants and essentially those of Constantine because in this one the problems of housing began to multiply (shantytowns, zones affected by landslides, old city....) and the emergency situations became frequent.

-SOP 02: it is located south of SOP N°01 and includes three neighborhood units (N°10-12-19). It occupies an area of 136 ha which represents 11.04% of the total area.

-POS 03: it is located in the south - east part of the city and it includes the neighborhood units No. 09 and 11. It has an area of 140 ha which represents 11.36% of the total.

-POS 04-05-06-07-08: all these POS are located in the western part of the city. They include the neighborhood units No. 17-18-04-14-20.

-POS 09: It concerns the two neighborhood units N° 15 and 16 and covers 114 ha.

This unequal distribution of POS areas is intended to meet several objectives. In total only 03 POS have been approved while 04 POS have been completed but not yet approved and this for very diverse reasons (problems of substance and form). Only 02 POS are still at the study stage. It is therefore still an incomplete city, unfinished and undergoing all kinds of transformations (Kassah, 2007).

Tableau 3 Distribution of the POS in the new city Ali Mendjeli.
Source : The DUAC cited in (Cherif, 2021)

POS	U.V	Superficie des POS	%
01	01-02-03-05-06-07-08-13	540	43,83
02	19-12-10	136	11,04
03	09-11	140	11,36
04	17	70	05,68
05	18	92	07,47
06	20	40	03,25
07	04	55	04,46
08	14	45	03,65
09	15-16	114	09,25
	Total	1232	100

4.7 The principles of development of the New City Ali Mendjeli

According to (Kassah, (2007) The organization of the new city responds to a set of development objectives that take into account certain economic, social and cultural imperatives. Its spatial organization as elaborated by URBACO (1992 Orientation Report) obeyed the following principles:

- Safety: it is essential to take into consideration the seismic aspect of the region by applying the seismic rules. This system is reinforced by a set of free zones allowing the regrouping of the population (park, garden, square and small square).

- Accessibility: this aspect is important for the proper functioning of the entire urban system. It is necessary to guarantee a satisfactory travel time for home-to-work trips on the one hand, and for access to the city's various facilities and institutions on the other. The link between the new town and Constantine is ensured by a public transport system involving both the public and private sectors.

- Attractiveness: the creation of a favorable environment is one of the conditions necessary for greater attractiveness. To this end, the city will be equipped with a range of facilities, some of which are regional in scope.

- Phasing: the construction of the new city will be carried out gradually, district by district. It has begun with district n°02. The facilities and businesses that will be created there will allow it to be autonomous until the rest of the city is built.

4.8 Ali Mendjeli’s street network and UVs configuration

The Ali Mendjeli urban plan, developed by the URBACO design office, reflects this desire. It proposes a set of hierarchical ways (boulevards, avenues, streets, passages, dead ends) and structured in orthogonally cut meshes, inside which the housing units and equipment take place. According to (Lakehal, 2017) ,This network of roads ensures that the city is organized according to "*a hierarchical ordering*" as the folowing: city-neighborhoods, neighborhood-units, residential blocks, and buildings. In total, the new city is subdivided into five large neighborhoods, each composed of four Neighborhood Units, making a total of twenty neighborhood units. In turn, the neighborhood units are divided into residential blocks, which are made up of apartment buildings (or pavilions in the individual housing areas) that form the smallest entities in the urban structure of the new town. As far as its centrality is concerned, according to (RO, 1994, 83), reported by Lakehal, (2017), the designers have chosen to organize the new city according to a system of "*hierarchical centrality*", ordered in a succession of centers of different sizes. At the lower level, there are "*proximity centers*"; they are conceived as everyday spaces intended to foster social and economic relations at the level of the "*immediate vicinity*" of the dwelling. The "*secondary centers*" constitute the intermediate scale; they must allow each of the five "neighborhoods" planned by the master plan to have its own center. To this end, they accommodate facilities "*which could not be found in each neighbourhood center, but which do not justify recourse to the main center*" (RO, 1994, 83) in (Lakehal, 2017).

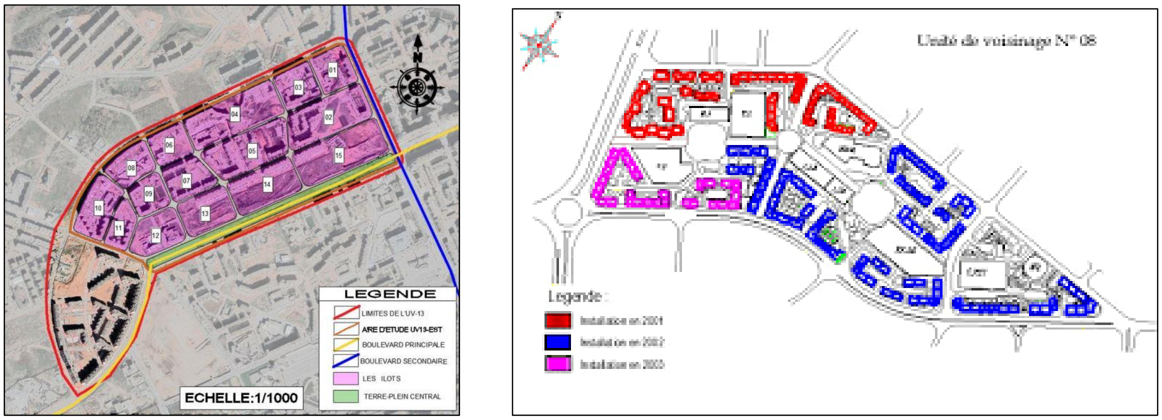


Figure 63 Left: Block division, neighborhood unit 13.
Source: (Benzagouta & Brunfaut, 2018)

The same author stressed that, the designers of the new city wanted to build an essentially "*horizontal"* city. Except for its median axis, along which buildings of relatively high height were to be erected,8 the rest of the urban fabric was to be composed essentially of buildings of roughly constant height, on the order of an average of six to seven stories. The eastern (UV 5) and southwestern (UV 18, 19 and 20) peripheries of the new town were reserved exclusively for single-family houses, thus offering a significantly lower urban landscape than the other neighborhoods. Each neighborhood consists of four neighborhood units. Thus, the city is divided into twenty (20) neighborhood units. They vary in size from 19.96 ha (U.V 08) to 120 ha (U.V 01) and in geometric shape. This heterogeneity in size and shape is the result of the topographical characteristics of the site, the number of inhabitants, housing and facilities (Lakehal, 2017).

The URBACO report added that the new town was designed as "*a reproduction, on a smaller scale, of the main center*", in a manner that ensure a certain autonomy of life for the neighborhood units (RO, 87). At the top of this system of hierarchical centrality is the "*main center*," intended by the designers as "the privileged place of urban life, the very heart of the city" (RO, 56). It was organized linearly along a rectangular esplanade 1,500 m long and 85 m wide, delimited by side streets open to automobile traffic, it is conceived as a dense and polyfunctional space, "*bringingtogether in a very limited perimeter all the tertiary, commercial, social, administrative, economic and leisure activities*" (RO, 78). Because of its location at the intersection of the two main boulevards of Ali Mendjeli, initially designated as principal Boulevard and Secondary Boulevard, the first is now called Boulevard of the National Liberation Army, while the second still has no official name. On the more general question of the naming of streets and boulevards of Ali Mendjeli , it is the most accessible part (Lakehal, 2017).

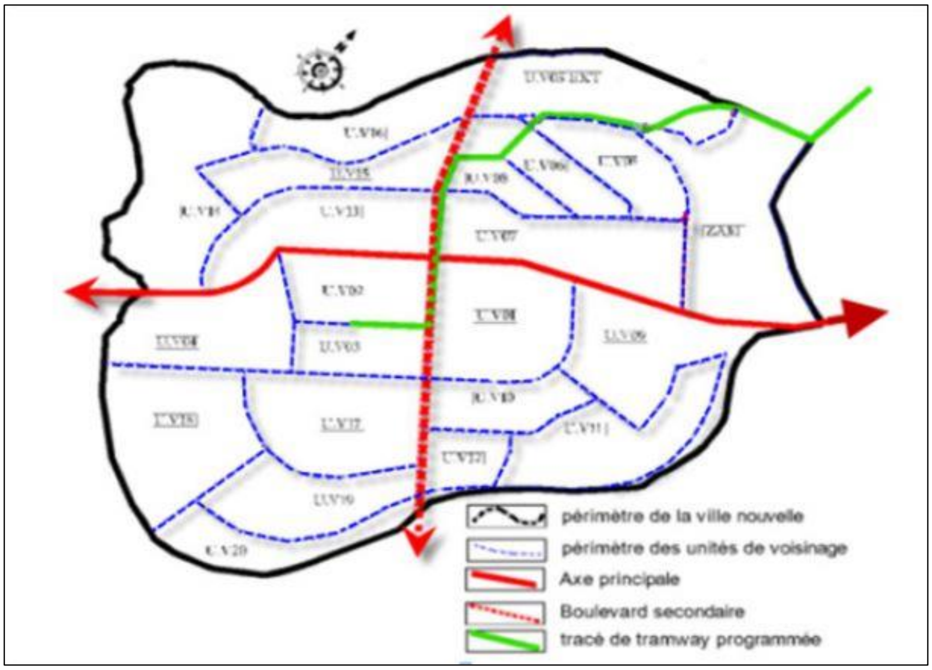


Figure 64 The main streets of the new town.
Source: (*Ville Nouvelle de Constantine – Recherche Google*, n.d.)

5. Constantine's Traditional Town

5. 1 The core of a metropolis

Constantine or Cirta of its former name is one of the oldest cities of Algeria. It celebrated the 2500th anniversary of its construction. One could even say that it is the oldest city of Algeria, since it was the capital of Numidia, the current Algerian East and part of Tunisia. It was the first national expression of the Algerian people against the Carthaginian hegemony (Benidir, 2003).

Constantine is the only inland metropolis of Algeria in a position of contact between the great North-South and East-West axes. It radiates far over the country. Cradle of civilizations rooted in the first historical times, it enjoys a network of cultural, social and economic relations, which extends far around the Mediterranean basin. This influence is facilitated by a rather dense road network which allows to link it to the numerous cities of "The Constantinois". On its current territory which is reduced to the minimum, it has a significant road network in good condition: 243 kilometers of national roads and 414 kilometers of wilaya roads, in addition to the project of coastal highway which also passes by the large cities of the interior, including Constantine. Those who first built Constantine chose a site that was very difficult to access. The Roché, which some call the "eagle's nest", is like a peninsula that can only be accessed from the south, by a small tongue of land, while everywhere gorges of varying depths, up to 175 meters deep, separate it from the rest of the region and therefore from the city (Benidir, 2003). But this city, far from being built according to a clearly defined prospective vision, was made, much more, from complementary actions sometimes, antagonistic other times, regulated by the major theme of the 19th century, that of salubrity and hygiene. These actions did not make it possible to clarify the urban space in a definitive way, since the pivot of the city that represents an urban center, the city center, could not find its place in this period and even later (Belabed, 2007)..

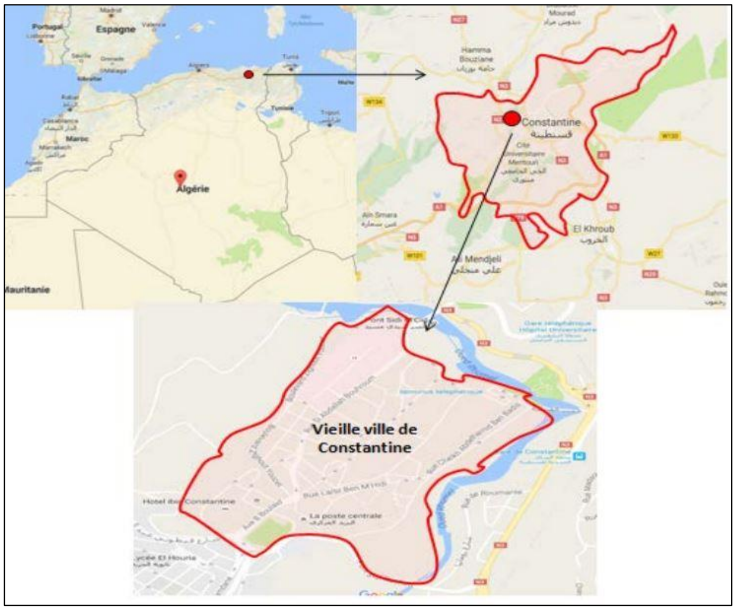


Figure 65 Situation of the old town in Constantine city.
Source : (Fantazi et al, 2018)

Figure 66 Constantine’s old town a secular site.
Source: Google Earth Pro 2021.

5. 2 The road network, an essential component of the old town public spaces

The city of Constantine presented a plan similar to that of Arab and Muslim cities: homogeneous structure, juxtaposition of elements, functional segregation, and hierarchization of spaces (Belabed, 2007).

It was divided into four main districts located at the corners: Tâbiya, to the southwest, Casbah, to the northwest, Kantara to the northeast, Bab ŔEl- Jebia to the southeast. From the gates, located in the south of the city, the main streets that allowed to cross the city from south to north started: a street from Bab El-Jedid leading to the Casbah district, two streets from Bab El- Oued, between which were located the main markets of the city; a street from Bab El- Jebia, leading to the district of Kantara and to the bridge over the Rhumel. Between these main streets, relatively wide and regular, a network of uneven alleys developed, which impressed the conquerors of 1837.

According to Kribeche & Lekhel (2017) , The analysis of the existing road system shows their importance in the urban structuring of the city. Their spatial organization allowed indeed to be able to move in the commercial zones, without having to pass by the residential zones and vice versa, and this through three degrees of importance of the roadway:

- The primary network: network frequented by all categories of the population, and where the most attractive activities of the city are developed, especially religious and commercial ones.

Thus the two streets which emerge from Bab El- Oued cross residential districts of the city, and define on their course to Bab El- Kantara the principal economic activities of the city as well as the strongest concentration of stores, which was worth the common name of "Souk Ettedjar". The great mosque is located near this route, in accordance with the urban organization of any traditional medina, the way that also starts from Bab El-Jebia to Bab El-Kantara is, as for her, an important link for the city, since it crosses a long route to connect two at a time two neighborhoods between them, and these neighborhoods to the outlying areas through the bridge El-Kantara. One of the roads coming from Bab El- Oued, as well as the one starting from Bab Jedid are residential roads, since they cross entirely the residential districts of the west of the city to end one in the Kasbah and the other also joins the Kasbah from Bab El Kantara. The connection of these paths with the shop space being moreover often marked by the addition of stalls.

- The secondary network: The rest of the lanes are grafted onto the main routes in order to drain the whole area of activities or all the residential parts of the city according to a hierarchical scheme of which the dead end is the last link (Kribeche & Lekhel, 2017).

- The tertiary network: the derbs, consisting of dead ends, this network is exclusively intended for the inhabitants of the houses concerned.

The residential districts, are thus preserved in their intimacy, and protected from all the inconveniences and nuisances which can be caused by the commercial activity, such as the noise, the pollution, the indscretion of the passers-by.

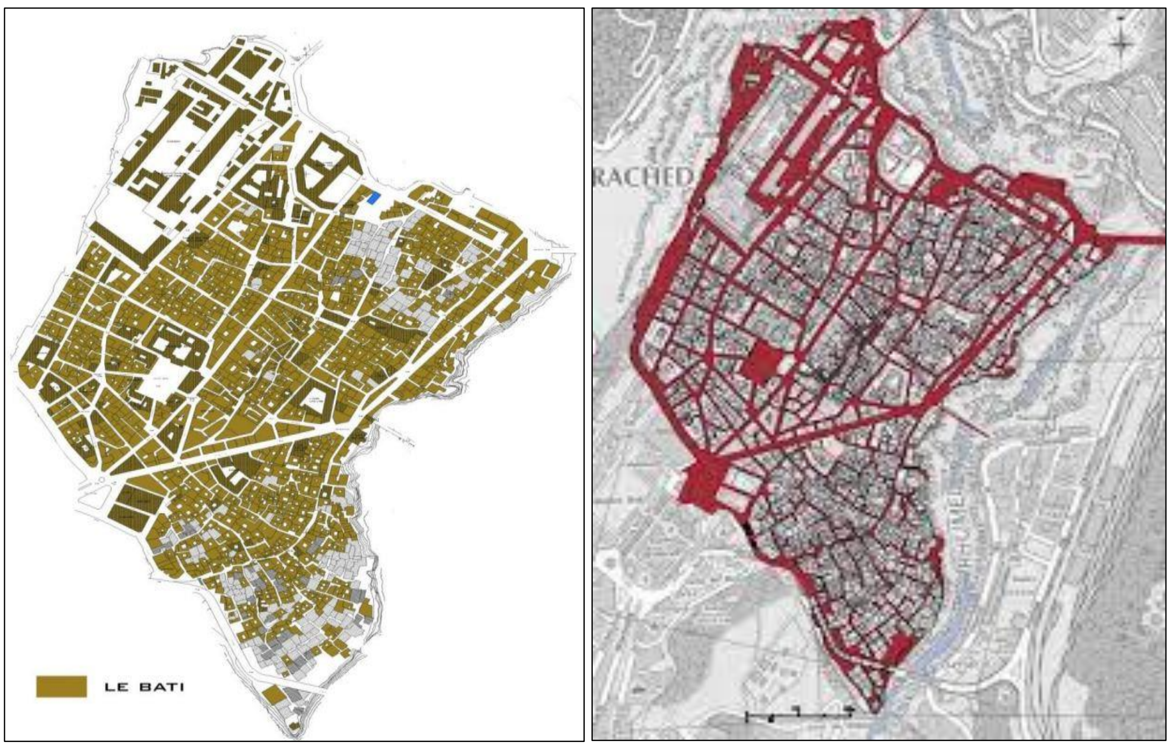


Figure 67 Left: constructed and non-constructed space of the traditional town
Source: (Fantazi et al, 2018)

The traditional layout of the streets highlights a road network established according to a gradual system, starting from "the street": public space, passing by "the alley": semi-public space, to finally arrive at the private space: "the dead end". The dimensioning of the lanes reinforces this graduation because: the more one leaves the main street the more the width decreases and the more the intimacy of the space increases. All these functionally differentiated areas are connected by an adequate and appropriate communication system, which allows the separation between the commercial and the residential area, the busy and the quiet space, the public and the private life.

Figure 68 Dead end derb shows less public areas Source: (*Recherche Google*, n.d.)

5.3 The alignment and grading work (1877)

In 1877, and just after the great breakthroughs, a new general alignment plan of the city of Constantine was drawn up (Figure 109). At that time, the development of the new European roads was almost complete. Only the smaller breakthroughs and the alignments were carried out over a relatively long period of time, which lasted until the end of the 1930s. This period led to the appearance of European buildings facades on the rectified traditional streets, and also to the disappearance of traditional stores in streets that had been preserved until then (for example Rue Combes 1993) (BAKIRI, 2011). This is how roads appeared in the heart of the native fabric with a mask of European style construction. The first phase of colonial settlement on the rock was manifested in the form of expropriation of houses and places belonging to the Turks, and the reallocation of certain building to other uses.Thus, the first partial alignments were made only by virtue of special authorizations. The rectification and piercing of streets were elaborated by the army and obeyed above all to security concerns. With the growth of the European population, the French, not being satisfied with occasional occupations, decided to divide the city, the ordinance of June 9, 1844 divided Constantine into two parts, one in the upper part preserved exclusively for Europeans while the other, in the lower part , for Arabs, by the future Caraman street. This bipartitionconfirmed the maintenance of the French on the Rock and put at their disposal half of a site built for the creation of their intra muros district (BAKIRI, 2011).

French military engineers cleared and levelled the market places (Négrier Square, Rahbet Es Souf, Camel Square) and improved their accessibility. He classified the streets into large and small roads. The streets Rouand, Perregaux, Caraman up to the meeting with the street of France, and that of Constantin or Grand, were part of the first category. The main streets were 7 m wide, with 1 m sidewalks on both sides, while the smaller streets were only 5 m wide. The plan projected a bridge, towards the end of the place El kantara, which was moved by the city council opposite the outlet of the street Rouand and in the continuation of the street Perrégaux (Belabed Sahraoui, 2007).

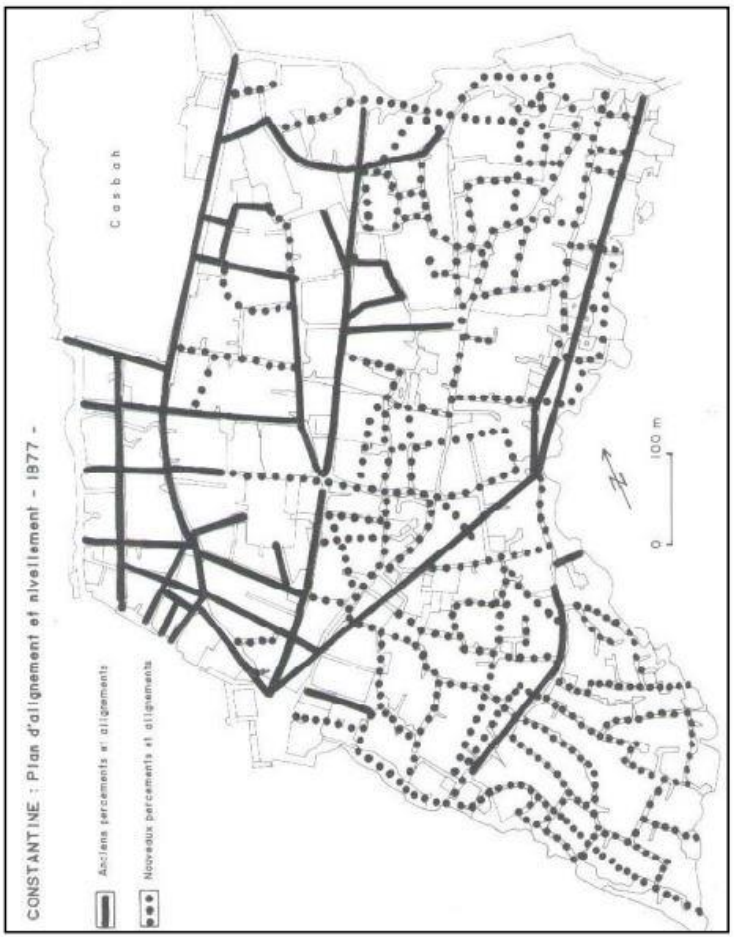


Figure 69 Alignment and levelling plan of 1877.
Source : Boufenara, 2008 IN (Bakiri, 2011).

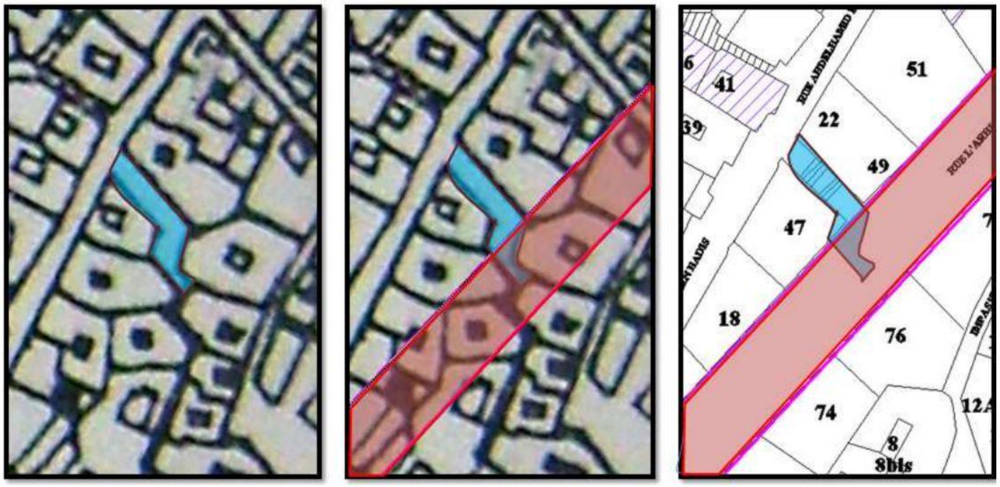


Figure 70 Dead end removed following the construction of a main commercial street
Source: (Bakiri, 2011)

5. 4 The residential area

The residential sector constitutes a significant expanse within the city, occupying a substantial portion of the urban landscape and occupying a considerable area within the Medina. This residential layout exhibited a deliberate orientation, positioning itself in opposition to the economic core, predominantly situated at the heart of the city. The evolution of this residential zone resulted from the juxtaposition of familial units, manifested through the construction of dwelling buildings, adhering strictly to a predefined pattern. This district is characterized by the intricate division into sub-neighborhoods, further divided into densely packed blocks, forming an intricate and closely woven urban fabric. The adherence to this systematic pattern underscores the meticulous planning and structured organization governing the residential quarters, reflecting a deliberate architectural and social design aimed at accommodating familial units within a cohesive and interconnected urban framework. This strategic arrangement facilitated communal interactions while upholding a distinctive spatial layout that contributed to the city's distinctive character and functional dynamics.

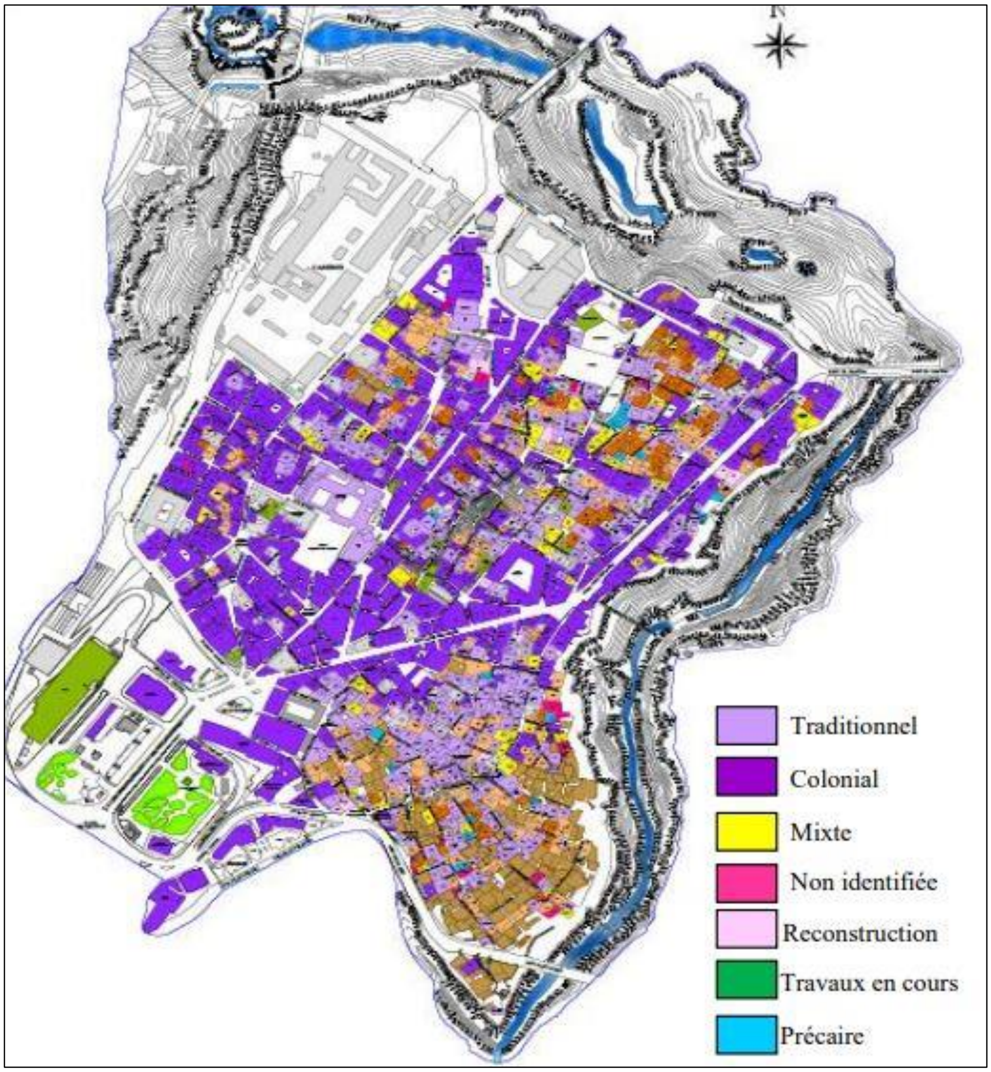


Figure 71 Composition of the urban fabric of the old town of Constantine.
Source: (Fantazi et al, 2018)

6. Conclusion

New town development has gained widespread acceptance as a planning technique for decentralizing congested populations and dispersing functions in major Algerian cities. This new town movement started in Europe at the turn of the twentieth century and has since become a major urbanization strategy in modern Algeria. Since the 1990s, the number of new towns built in Algeria has expanded dramatically. several communities have been planned and built during the last three decades. Algerian urban planners integrated lessons learned from previous European new town initiatives while deciding on site, economic development, and transit strategies. Because of the migration of industry and other critical sectors, many new towns have effectively become the growth centers of their respective areas. These new towns, however, are hardly ideal models of energetic and active metropolitan regions. The idea behind utilizing the residential neighborhood unit as a template for new construction was to create a serene and tranquil dwelling area apart from the rest of the typical city structure. The residential neighborhood unit design, together with comprehensive master planning and zoning aimed at creating functional separation, established the theoretical underpinning of Algerian planning practices after half a century of growth. This strategy is highly operable and simple to adopt for various governments and building enterprises. The master plan defines roadway networks, with primary roads serving as borders for various residential neighborhood units. The distances between the main roads and the minor streets, in turn, are determined by the unique requirements of each local residential neighborhood unit. This residential neighborhood unit concept, on the other hand, is built on the concepts of "auto transportation first" and "functional distribution." The practical consequences are a lack of street vitality and uninteresting, one-purpose communities. This strategy has been increasingly questioned from the standpointsof sustainable development and urbanization promotion.

Ali Mendjel is a product of its time, a pole of organization of the urban expansion and the main lever of the policy of desertification and decentralization of activities, however it has difficulty in managing the time factor. Ali Mendjel was conceived as a completed complex, supposed to meet the needs of today's population through an airy and equipped space, differentiated traffic lanes for pedestrians and vehicles, and an important construction capacity. Its dynamism and the interrelationships it is supposed to establish with its environment plead for its further development, creating an attractive urban and social framework where nothing or almost nothing should be missing. Beyond its appearance, which everyone can appreciate in their own way, Ali Mendjel, contains the capacity to renew itself, relying on its dynamics as well as its internal tensions.

Algerian cities prior to the modern period are examples of cities that were neither planned or built. These cities grew and formed spontaneously and randomly in response to the needs and desires of civilization at various times. Algerian ancient cities are classified as "organic cities" by this quality. Organic development is a style of planning that allows for changes during the process and bottom-up development. The major goal of this chapter was to delve deeply into the notion of Algerian organic cities and compare it to new layout types by investigating the physical fabric of both and discovering the hidden meanings behind the composition and arrangement of its constituents. Constantine's traditional town is an example of an organic city; they give sufficient evidence to support the argument that organic cities develop their own type of order, despite their seeming irregularity. Any in-depth examination of organic structures can disclose the principles and rules of urban expansion, which are based on an evolutionary fulfillment of people' requirements during the spatial creation process. The true nature of organic cities, which is highly praised across the world, appears to be formed by a balance between what the city is and what the city needs to be. When the two Algerian cities were examined, the study revealed that old realm cities have more similar morphological qualities to modern town towns. These characteristics are as follows: denser urban fabric, more fractured forms and less linearity, a strongly defined urban core, and less integrated residential districts. These discrepancies appear to be reliant on varied conditions in each region, but without examining a wider group of cities, some of these differences may simply be connected to specific qualities of each city generated by geography and location. In this respect, when more comparable conditions exist, it is typical to observe extremely similar urban fabric in Islamic cities from various areas, although variances may also be seen in towns that are adjacent to one other but have less common local conditions.

CHAPTER SEVEN

ANALYSIS RESULTS AND DICUSSION

1. Introduction

The spatial distribution of movement behavior in street networks is essential for the functioning and dynamics of a city. Understanding the influences that affect pedestrianmovement is critical for forecasting traffic flow and improving efficiency, safety, sustainability, and livability in urban contexts. Prior research has used elements such as the network's morphological and physical characteristics, land-use patterns, and residential and employment densities to explain movement flows in urban street networks (Dasyles, 2000; Hillier & Hanson, 1989). Yet, the geographical distribution of movement flows is tied to two sorts of effects: the movement potentials of the street network and the spatial behavior of individuals. Individuals' spatial behavior refers to how people perceive distance and choose the shortest routes to their destinations, whereas movement potential refers to the expected distribution of movement volumes in the street network when the shortest routes between all pairs of origins and destinations in the network are considered. 'The objective to-movement and through-movement potentials of the network itself contribute what we would term network effects on shaping flows; and these are changed by how human brains contribute distance effects through how they interpret distance...' as stated by Hillier (B. Hillier, 2007). Understanding how urban center patterns emerge in the physical environment and how they promote diverse social processes continues to be a major problem for current urban design. The central goal of this thesis has been to comprehend the meanings of built environments through investigations into the extent to which movement behavior can be explained by urban layout structures beyond the premises of physical design, as well as an examination of these dynamic relations in relation to the street network. This study first provided a method for assessing configurational aspects of urban layouts using the space syntax approach, then investigated the externalities of urban spatial on pedestrian movement distribution. This work advanced the idea that analyzing the urban structure might assist forecast mobility in traditional configurational models as well as n the new ones. This research has delved extensively into the domains of configurational studies, in order to extend spatio-morphological analysis in general, and the space syntax model in particular, as the major component of a more integrated urban theory.

This last chapter's goal is to synthesize the key results and highlights of the preceding chapters, which include the following: The space syntax centrality metrics capture spatial structures represented by the urban configuration topological and angular measures in both study areas; secondly, space syntax centrality is a critical variable in models for predicting the variation of pedestrian volume movement; and thirdly, configurational centralities variables are the main determinants of the pedestrian model. This chapter revisits the idea of 'natural movement' and'movement economy' and argues for the necessity of adding function aspects to construct a more inclusive theory, based on results and practical research in the old and new town of Constantine city, and with the assistance of relevant theories. This chapter also addresses the potential ramifications of the empirical findings. On the practical side, it argues for the relevance of this study for morphological analysis and socioeconomic studies, as well as for urban planning and design. The limits of this research are then discussed, and next measures for developing the suggested framework are offered. Lastly, some final remarks are made.

2. Research design and street network modeling

2.1 Urban form growth of both case studies

Ali Mendjeli is a new town that was formed and developed in the second part of the twentieth century, closely following the contemporary urban planning concept. This concept is characterized by a tree-like street layout related with the notions of the functional hierarchy of streets, and the neighborhood unit. The new town was designed with greater open areas, a lower mix of land uses, broader primary roadways, and lower density. Ali Mendjeli's new town features a reasonably high density of residences with a commercial ground level.

The old Town neighborhood was created in an unplanned manner, with a considerable roadway network and land use variances separating its sub-areas. The other neighborhoods have retained their original layout with curvilinear street patterns irrigating a very compact urban fabric with traditional commercial activity along winding roads beneath traditional houses. The neighborhood established in the colonial period following a modernistic approach with rectilinear routs (Trik jdida, Rue de France, Rue Larbi Ben Mhidi) with a high level of retail.

Recent research indicates that the variations in these planning techniques may be reflected in movement patterns (Vinemen, 2002). Main roadways account for the greatest accessibility to desirable land uses, such as commerce, and the highest circulation volumes in regions designed using pre-modern notions. The notion behind modern planning concepts that adopted the functional hierarchy of streets, on the other hand, was the separation of thorough-movement from accessibility.

The major streets were intended as roadways for fast moving motorized vehicles with limited access to nearby land uses, and access was only permitted from local and less central streets. The present study's goal is to determine the impact of different design techniques on pedestrians. This study expands current research on contemporary built environments in cities with pre-modern portions as well as cities developed entirely along modernistic lines. The features of the many textures observed in new developments or old neighborhoods can be summarized or reduced in two 'typical typologies' depicted in the table 7 below.

Figure 72 The investigated urban areas (Auther 2021)

2.2 Space Syntax Method Basic models and concepts

The space syntax model arose from observations that the spatiality of society and the sociality of urban space occur concurrently in cities, and it addresses the overall topic of how space and society are inextricably linked. From the standpoint of spatial configuration, it focuses on portraying the spatial system as a continuous network in which distinct spatial pieces are integrated as a whole (Hillier & Hanson, 1989; Hillier, 1999). The social meanings of urban spaces are theorized and reinterpreted in Hillier's thesis as the social ordering that would be recorded by the interaction between spaces and further reflected and assessed by the geometric qualities of a continuous space network. Measuring the relatedness in this spatial network is used in the space syntax model to determine the social and cultural relevance (B. Hillier et al., 1993). Figure 115 depicts he way in which urban places are linked produces many associated social structures. The spatial shallowness/depth from one root space to other accessible spaces may be unfurled by creating the justified graph and measuring the length of the connections connecting them.

The axial line (Hillier & Hanson, 1989), the segmental line (Turner, 2001; Turner, 2007; Hiller and Iida 2005), the convex space (Hillier & Hanson, 1989), and the isovist (Turner and Penn 1999) are the four typical methods used in the space syntax model to describe the space and construct the continuous spatial network for analysis. As a result, these divided spaces not only offer discrete places in the built environment, but also demonstrate the connectedness between adjacent spaces. The spatial configuration is a well-specified spatial system in which the shallowness of a space is determined by the relatedness of the associated adjusted graph roots from the space. The shallowest spaces arise when all spaces are directly connected with the original space, but the deepest spaces appear when all spaces are connected end to end in a non-linear sequence from the root space.

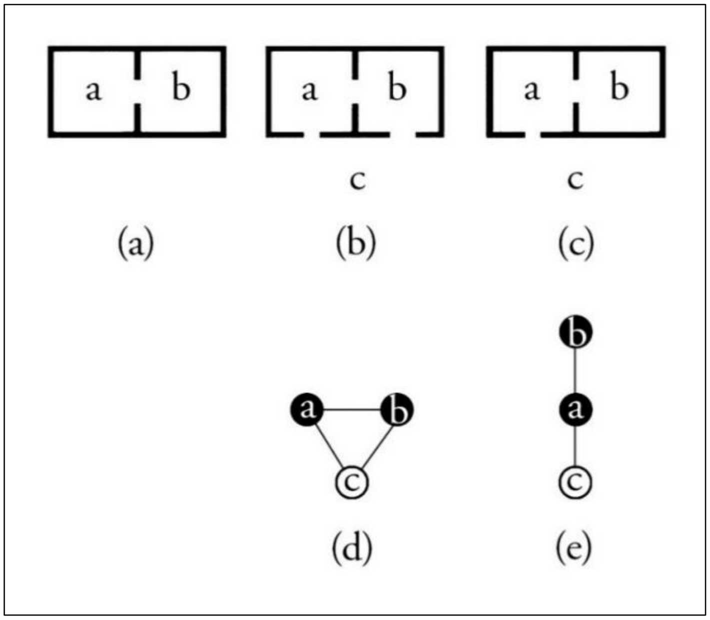


Figure 73   A simple diagram of generating the configurational network from spatial layouts. Source: (B. Hillier, 1999).

The scale of analysis is another important notion in space syntactic analysis of the spatial graph, because the adjusted graphs change depending on the definitions and modifications of the scales. In the axial model, the radius of the buffer zone is defined by the step depth - the topological turns. In the axial analysis, the local scale is three steps at the given radius, while the global scale is infinite radius. The radius in the segmental model can be determined by metric distance (total length of the shortest route), topological distance (sum of turns along the fewest turn route), and angular distance (accumulative angular change along the least angular change route). In practical investigations, the metric radius has been proposed to be more successful than other formats of the radius in segmental analysis because it may depict the interaction between energy expenditures and cognitive exertion necessary for traversal through the spatial network. Also, the metric definition of the radius is consistent with transport models in which journey distance is fundamental to people' mobility patterns, which mirrors the trip models (B. Hillier, 2014). As a result, the segmental model distinguishes between geographical scales based on the length of travel: in general, radii less than 2, 500m are more local and more pedestrian- or biking-related,whilst radii greater than 10,000m are more likely to be global and associated to vehicular-oriented journeys.

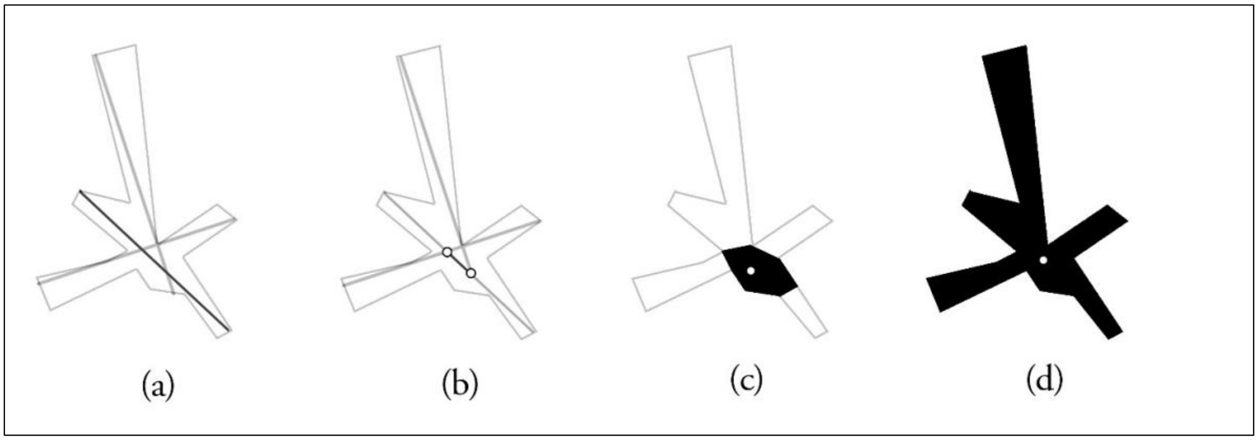


Figure 74 Methods of segmenting urban space in the space syntax theory

3. Identification of the urban accessibility in case study towns

3.1 Analysis method and Data

3.1.1 The axial method measure

The spatial layout of the street networks in the research cities was investigated using the space syntax methodological framework, which presents a topological-visual approach of analysis. A fictional street network represents the basic component of this design. The study is based on an axial map, which determines the smallest set of straight axial lines (visible lines) that encompass the city's street network. The axial map displays small-scale regions within the urban built environment and allows the built world to be depicted as people on the ground see it. The axial map is then turned into a connectivity graph, with the axial lines and intersections between lines serving as the network's nodes and connections, respectively. The axial map is then turned into a connectivity graph, with the axial lines and intersections between lines serving as the network's nodes and connections, respectively.

The centrality level of each axial line in the network is then determined using centrality measures that use graph connectedness, i.e. by computing topological distances (directional changes) between axial lines. Three topological space syntactic metrics are used to calculate the centrality degree of each axial line: Connectivity, Integration, and Choice (Hillier & Hanson, 1989 ; Hillier, 1999). Each metric is described in detail below:

Connectivity: The number of axial lines that are directly connected to one other. In the hypothetical network shown in Figure 118, for example, axial line a is directly connected to three other axial lines (c, d, and b), hence its connectivity value is 3, the greatest in the network.

Integration: It denotes the accessibility level, which is the ability of a certain axial line in the axial map to move. The closest topological distance between any particular axial line and all other axial lines in the system is shown by Global Integration: the smallest topological distance between it and all axial lines in the axial map. In the proposed hypothetical network, for example, axial lines a and d are the most integrated (i.e. accessible) in the network. The total distance between each of them and the other axial lines is 8. For example, the distance between axial lines a and c, d, and b is one step, two steps between axial lines a and e, and three steps between axial lines a and f (i.e. 3 x 1 + 1 x 2 + 3 x 1 = 8). In comparison, axial line f has the lowest network integration (14 steps). The distance between axial lines f and e, d, and an is one, two, and three steps, respectively, and the distance between axial lines f and c and b is four steps (i.e. 1 x 1 + 1 x 2 + 1 x 3 + 2 x 4 = 14).

Choice: It denotes the intermediary level, which is the axial line's through-movement potential. This metric shows the extent to which a particular axial line serves as a network transitional place, that is, the number of times any location is encountered on a journey from "origin" to "destination" for all pairs of axial lines in the whole urban region (Global Choice).

For example, in the hypothetical network, axial lines a and d have the highest choice value in the network; 6 out of the 9 shortest paths (between pairs of axial lines that are not directly connected) in the networks pass through these two axial lines (axial line a \sis passed through the shortest distance between f-c, f-b, e-c, e-b, d-c, and d-b, while axial line d is passed through the shortest distance between f-a, f-c, f-b, e-a, e-c, and e-b). Axial line f, on the other hand, has the lowest Choice value since no shortest path between pairs of axial lines runs through it.

Local Integration and Local Choice denote integration (accessibility) and intermediary only up to a specified topological distance radius, respectively. For example, when the radius equals 3, the centrality is measured up to two axial steps away from each line in each direction. Local Integration and Local Choice are computed at the following topological radii in this study: R = 2, 3, 4, 6, 8, and 10. The global measurements are calculated in relation to the full axial map (R = n). After normalization, the Integration and Choice measures are shown below (Hillier & Hanson, 1989; Turner, 2001).

3.2.1 The segmental method measure

Segment analysis is one of the most essential analyses in space syntactic practice for understanding movement. It was first employed in axial segment maps and then in road center line maps as an attempt to address the 'segment problem' (Turner, 2007). Additionally, the increased requirement to investigate large city systems has resulted in the widespread usage of road center line maps rather than hand-drawn axial maps. The angular segment analysis, in particular, has been employed since the turn of the millennium and is connected to the cognitive behavior of a person traveling in space who is likely to take the least angular path from point A to point B. The total number of overlapping trips traveling through a segment, assuming that every segment is an origin and every other segment is a destination choice (Turner, 2000).

Recent theoretical works of Hillier, (1999)Turner, (2001), and empirical work of Conroy (2001) indicate that individuals conserve angle when moving in urban space . This means that shallow changes in the direction of movement should be regards as minor shifts from one space to the other. Substantial changes in direction might be viewed as purposeful acts of navigation. This could be incorporated in to the fractional J-Graph as low changes in angle between two axial lines that have shallow changes in depth (near 0) and sharp changes in angle as being big changes (near 1), paths having several changes of direction might be 'further' in the J graph then simple ones.

This implies that in urban public areas, the angular relationships between streets influence how people orient and move themselves in and around the built environment. When changing directions, individuals prefer routes where the angles between streets and street intersections are near to 90° or 180°. People get disoriented in urban blocks with unusual angles like 30° and 60° (van Nes, 2017) . Conroy Dalton observed that individuals choosethe longest roadway with the smallest angle to their desired direction. In other words, individuals take the shortest path feasible to avoid the complexity of navigating metropolitan street grids (Dalton, 2001).

The main consequence of angular segment analysis is that it allows one to see the probable choice of routes in a network by using the way individuals orient and move themselves. This includes people's cognitive assumptions about the network in terms of angles or linear paths.

Figure 119 illustrates the angular weighting utilized in space syntax. According to Dalton (2001) Shallow angles of incidence around 180° are given a numerical value of zero, whereas acute angles near 90° are given a numerical value of one. The determination of angles in roadway networks is dependent on two fundamental considerations. First, People find it easier to navigate constructed settings when the street network is not dominated by 'strange' angles. Second, while taking shorter bends toward their goals, people linearize their pathways. Angles between street segments in cities are often rounded to 90°. Turn subject memory is better for right angles, thus when in question, a turn is rounded to 90° for better positioning of oneself while picking a route for a journey in the metropolitan network (Turner

2001). In general, there are three sorts of turns in cities for people: no turn, fork, and right angle (Dalton, 2001)

In general, segment analysis is concerned with the change of direction when traveling from origin A to destination B (Turner, 2000). The fundamental underlying concept of angular segment analysis is the smallest change in direction. A distinction must be made between the minimal angle path and the shortest distance path as a Euclidean measure between two urban system sites. A visitor will mainly choose the shortest angle path, while a local will mostly take the shortest Euclidean distance (Turner, 2000).

3.2.2 Angular Segment Analysis Measures

a. Angular Connectivity

The cumulative turn angle to all other lines is considered as the segment analysis measurement of angular connectivity. The turn angle is weighted so that a 180° angle corresponds to a cumulative weight of 2 and a 45° angle corresponds to a cumulative weight of 0.5. Looking at the example in figure 120, we can see that the measure for a segment B is calculated by adding angle x to angle y (Turner, 2001).

Then, Angular connectivity value is calculated as B= x + y = 0.333 +0.5

b. Integration measure

Integration measure in angular segment analysis is an excellent predictor of each segment within a metric radius's potential to be a highly demanded destination. In other terms, the measure predicts the to-movement potentials for each segment by measuring on all of the system's shortest angle pathways from all origins to all destinations (Turner, 2001).

Hillier's integration calculation = (NC * NC) / TD NC: node count , TD: total depth

Angular integration analysis = NC/MD = NC/(TD/ND) = NC * NC/ TD MD: mean depth

The integration in segment analysis each street segment is weighted by the angle value of its connection to other segments. Each axial line is divided into several street segments. At each junction, an axial line is splitted, and the interactions between junctions in a street network are now considered (Turner, 2001).

c. Choice measure

Choice is measured automatically in DepthmapX program for each radius. DepthmapX calculates the best option for each radius automatically.

It simply evaluates the probability of each segment element being chosen as the shortest path by walkers (considering a small radius) or by automobiles (when considering a big radius) or both. Hence, choice denotes a segment through movement potential in a spatial system. Turner (2001) defines the computation as for all conceivable pairs of origin and destination sites, shortest path routes from one to the other are generated (Turner, 2001).

According to Al_Sayed et al., (2014), every time a node is traversed on the path from origin to destination, its choice value is increased." When DepthmapX calculates the shortest angular path within in the system, it assigns a value of '1' to every segment along the route from any origin to any destination. If the shortest routes pass through an element twice, the angular choice computation assigns the value '2' to that element. This process is repeated until the algorithm has found and calculated all of the shortest angle paths. It should be noted that both integration and choice can be incorporated in a single measure. This enables the identification of network portions that serve as both a prospective destination and a route of transit. This measure will then restrict the attention on fewer and more significant aspects within the system that have the characteristics of being a potentially desired destination as well as a desired path for travel. The amalgamation of integration and choice into a unified measure proves instrumental in pinpointing network segments that not only act as potential destinations but also serve as essential transit routes. This consolidated measure efficiently focuses attention on fewer yet more critical aspects within the system. Such segments possess distinct attributes of being both sought-after destinations and preferred paths for travel. This convergence empowers planners and analysts to identify pivotal nodes and routes that hold dual significance, streamlining the planning process by prioritizing elements that embody the dual characteristics of desired destinations and efficient travel pathways. This nuanced approach aids in delineating key components within the spatial system that possess a multifaceted nature, serving as both attractors and facilitators of movement, thus optimizing the allocation of resources and decision-making processes for effective spatial organization

Additionally, the incorporation of both integration and choice attributes into a singular evaluation tool refines the planning process by highlighting spaces that exhibit significant potential for enhancing connectivity. This approach guides decision-makers in allocating resources strategically, fostering development in areas that amplify the overall system's functionality and accessibility.

Ultimately, this integrated approach aids in establishing a more resilient and efficient spatial system. By identifying and prioritizing spaces that serve multiple purposes—both as desired destinations and efficient pathways—it paves the way for a more cohesive and adaptive urban or spatial layout. This comprehensive understanding informs strategic interventions and development initiatives aimed at creating a more interconnected and accessible environment for users.

4. Syntactic analysis of urban fabrics

The recognition of the manifold benefits associated with walking has catapulted the concept of "walkability" into a new realm of significance, heralding it as a catalyst for promoting physical activity and healthier lifestyles. This paradigm shift has positioned walkability not only as a mere urban planning consideration but as a crucial facet within the ambit of environmental justice. Consequently, it has emerged as a pivotal indicator, reflecting the physical quality and inclusivity of urban areas.

This newfound perspective on walkability has sparked an upsurge in the quest to unravel the intricate interplay between various conditions embedded within the built environment and the walking behaviors exhibited by urban inhabitants. This burgeoning interest stems from an inherent recognition of the complexity woven into the fabric of urban landscapes, where a multitude of factors converge to shape the walking patterns and habits of individuals.

The growing demand to comprehend this nuanced relationship underscores the need for a holistic understanding of how the built environment, encompassing infrastructure, land use patterns, accessibility, safety measures, and aesthetic elements, influences and potentially shapes walking behaviors. It underscores the inherent need to decipher the synergies between these diverse elements and the walking choices made by individuals, communities, and societies at large.

In essence, the evolving discourse around walkability transcends its mere function as a measure of urban convenience. It now serves as a critical lens through which to assess not only the physical attributes but also the socio-economic and environmental dimensions of urban spaces. This shift in perspective instigates a deeper exploration of the complex dynamics between the built environment and human behavior, fostering a deeper appreciation for the profound impact that walkability can exert on the overall well-being and equitable access to urban spaces.

Consequently, this heightened focus on comprehending the intricate relationship between the built environment and walking behaviors is instrumental in informing urban policies, guiding urban design interventions, and fostering the creation of more inclusive, accessible, and healthier communities. It embodies a paradigm that champions the fusion of sustainability, equity, and livability within the urban landscape, aiming to create environments that not only facilitate physical activity but also nurture vibrant, cohesive, and thriving communities.The association between the spatial configuration and pedestrian behavior at the street level has been investigated mostly within the conceptual and methodological framework of the space syntax approach. This framework is based on a topological-visual analysis of the street network called the axial map, defined as the smallest set of straight axial lines covering the urban street network. These studies have been conducted with respect to the concept of "natural movement," which means that the configuration of the street network determines extensively the distribution of movement within that network independently of other variables.

Figure 75 The old town spatial configuration patterns: (Author 2021)

Figure 76 New town spatial configuration patterns: (Author 2022)

4.1 Decoding the urban grid

Topological centrality within urban areas is a crucial factor defining the frequency and intensity of social interactions. Capturing this pivotal centrality involves a meticulous process where a network of axes is meticulously mapped onto a system, and the intricate interconnections among these lines are thoroughly analyzed. The metric that reigns supreme in this analysis is spatial integration, a pivotal measure that delineates the extent of movement along an axis and its interplay within the surrounding urban fabric.

The assessment of each axis unveils its unique "integration value," a quantifiable representation influenced by various factors, including the number of axes present and the topological distance separating them. These values paint a nuanced picture of spatial significance, highlighting the varying degrees of importance each axis holds within the urban layout.

An essential tool in understanding this concept is the integration core map. These maps serve as visual representations of syntactic centrality, showcasing the top 5-10% of the most strongly integrated lines evenly distributed across the urban landscape. They serve as comparative tools, allowing analysts to juxtapose and evaluate the total number of spaces influenced by these robustly integrated axes.

This meticulous approach illuminates the heart of urban dynamics, shedding light on the pivotal arteries that dictate the flow of movement, interactions, and activities within a cityscape. By deciphering the spatial integration and centrality of these axes, urban planners gain invaluable insights into the fabric and functionality of urban spaces, aiding in informed decision-making for future developments, zoning, and infrastructure enhancements.

The utilization of integration core maps not only serves as a tool for analysis but also as a guiding principle in the evolution of urban landscapes. It empowers planners to strategically allocate resources, optimize spatial utilization, and foster vibrant, interconnected communities. Ultimately, this in-depth understanding of topological centrality and its visualization through integration core maps forms the bedrock of informed urban design, aiming to create inclusive, efficient, and socially cohesive environments within our cities.

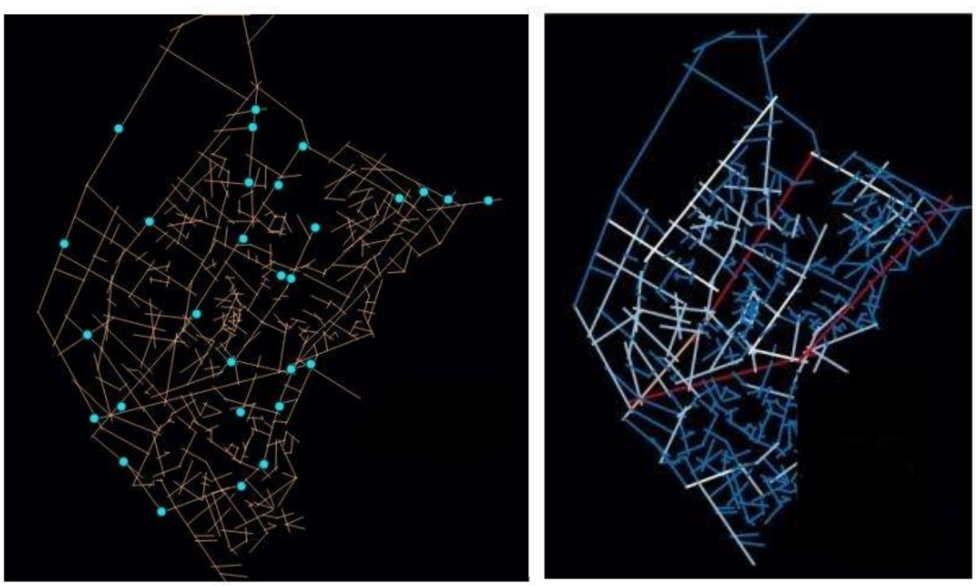


Figure 77 Survey points in the old town and its connectivity map
Source: (Author 2022)

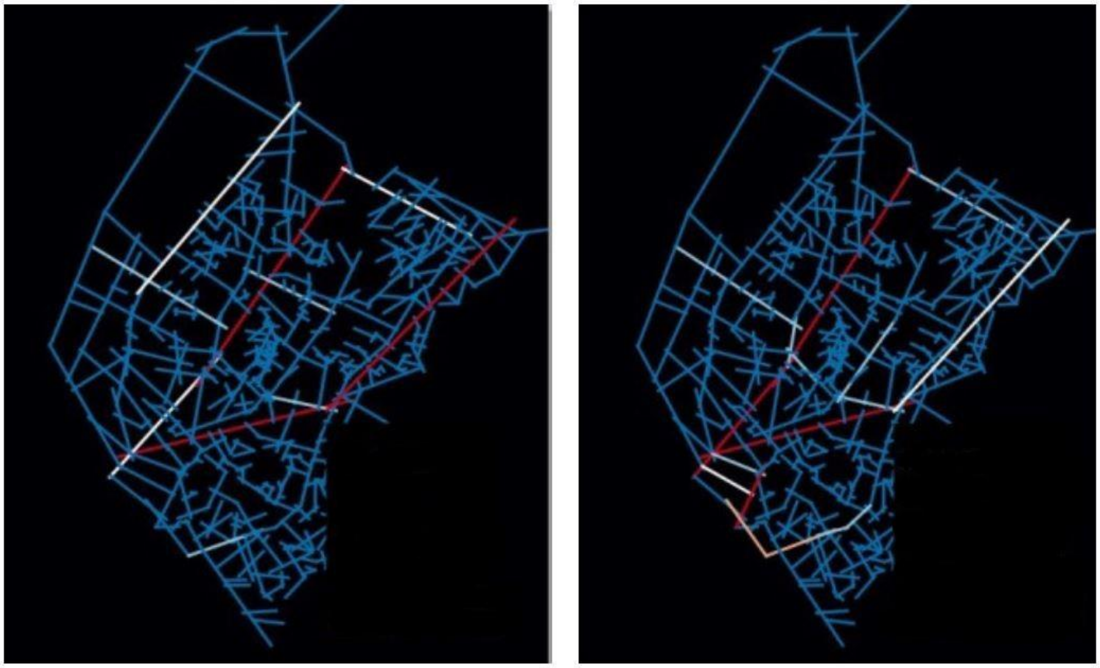


Figure 78 Sample of syntactic axial analysis of the old town’s choice measures.
.Source: (Author 2022)

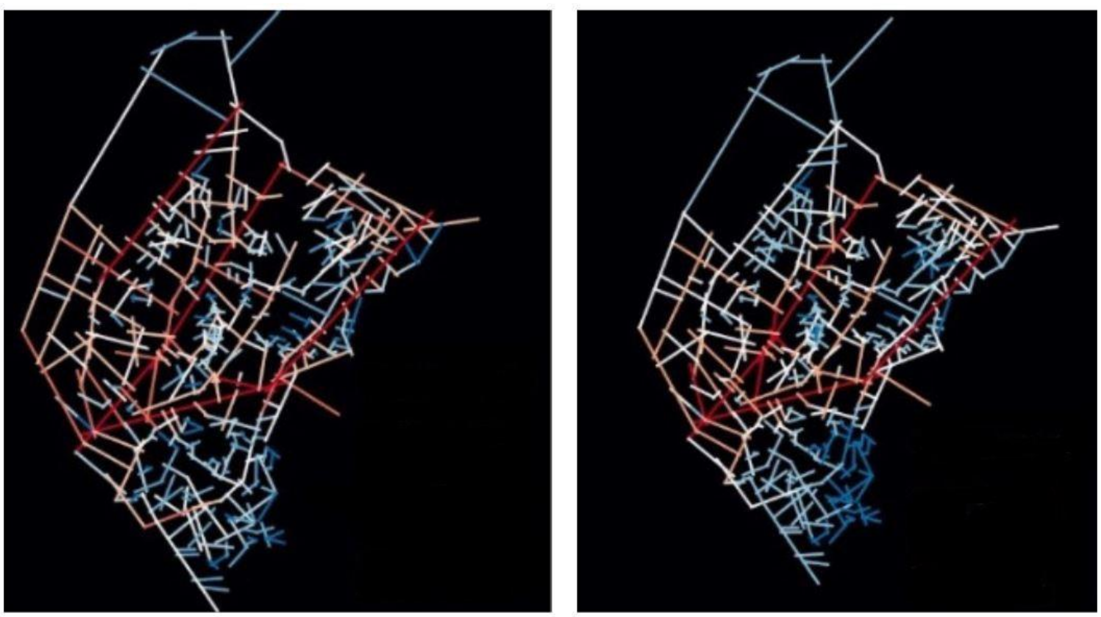


Figure 79   Sample of syntactic axial analysis of the old town’s integration measures
Source: (Author 2022)

Figure 80 The urban layout of Ali Mendjeli neighborhoods.
Source: (Author 2022)

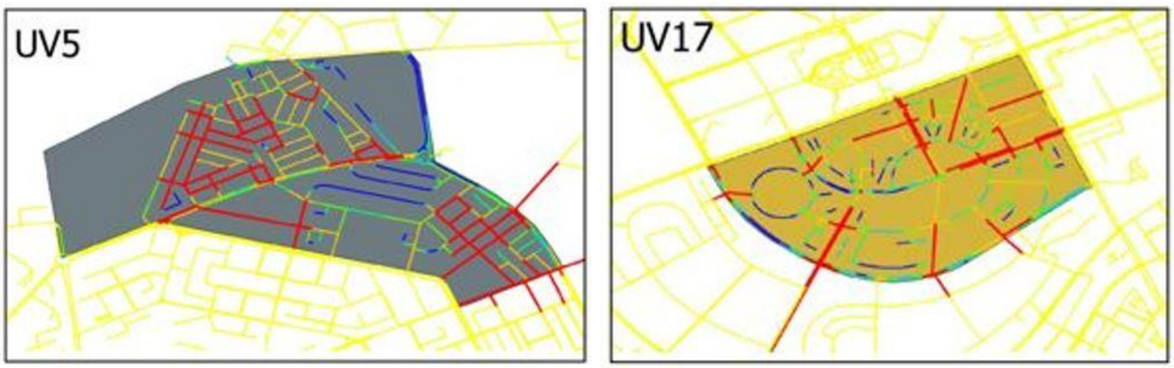


Figure 81 R3 micro centers configuration formed urban units
Source:(Author 2022)

The comprehensive examination conducted on the connectivity between the old town and new towns has unveiled a significant disparity within the findings, accentuating the distinctive characteristics entrenched within these contrasting urban locales. In the sprawling landscape of the new town, a discernible pattern emerges as some segments exhibit an aggregation of remarkably high connectivity values, standing in stark contrast to others entrenched in markedly low connectivity values. These pronounced variations paint a nuanced picture, portraying the intricacies of the urban fabric within this contemporary sector.

Within the new town's intricate network, the areas boasting the highest connectivity values predominantly align with the primary axes that serve as the foundational framework shaping the town's structural essence. These bustling thoroughfares not only define the town's physical form but also present an extensive array of potential pathways, offering a plethora of choices for pedestrian movement routes. The pronounced disparity between these highest connectivity values and the contrasting lower values denotes a distinct delineation, yet the differences among the lowest values in the old town's axes remain less observable.

To navigate through these intricacies and discern the underlying patterns with greater clarity, a recalibration of value symbology becomes imperative, necessitating a reclassification based on their distribution across the urban landscape. The adoption of quartile symbology emerges as a promising approach, presenting an effective means to discern the subtle variations and delineate the intricate spectrum of connectivity values prevalent within these urban domains.

This recalibrated connectivity map offers a nuanced portrayal, unveiling specific segments that intricately nestle within the heart of neighborhoods or seamlessly link two distinct locales. These notable segments, strategically positioned amidst the urban expanse, serve as pivotal connectors, bridging communities and enhancing accessibility within the fabric of the urban landscape. This detailed analysis illuminates the pivotal role played by connectivity in forging connections and fostering accessibility, laying the groundwork for informed urban planning strategies geared toward creating more cohesive, accessible, and interconnected urban environments.

4.2 Geometric analysis

In the context of the urban landscape under scrutiny, the lowest echelons of global integration emanate from the intricate morphogenetic processes that delineate the evolution of individual neighborhoods, operating largely independent of the overarching structural design of the town. This divergence in integration levels serves as a testament to the diverse trajectories of development that these distinct locales have embarked upon, contributing to the varying degrees of connectivity within the urban fabric.

Among the myriad axes that weave through this urban tapestry, DidoucheMourad street, Larbi Ben Mhidi Street, Abdallah Bouhroum road, Bd de La Belgique street, Kharrab Said road, Boulklab Mustapha, and Rouagh Said Road emerge as the epicenters boasting the highest value of global integration. These bustling thoroughfares stand as pivotal conduits, facilitating extensive pedestrian traffic and serving as primary arteries that transcend the confines of their immediate service areas. The perpetual activity witnessed along these avenues underscores their significance as bustling lifelines, fostering continuous movement and interaction among inhabitants and visitors alike.

Moreover, the reverberations of high integration values extend beyond these main axes, as certain streets intricately connected to them also exhibit commendable levels of integration. This interconnectedness cascades through the urban network, fostering a web of pedestrian movement that extends its reach far beyond the confines of individual streets or neighborhoods.

Amidst this intricate network, it's noteworthy to highlight the presence of exceptional axes strategically positioned at the nexus of neighborhoods or serving as vital connectors between two distinct locales. These remarkable pathways exhibit high levels of local integration, acting as pivotal hubs that foster localized movement and connectivity within the urban tapestry. Their significance lies not just in their function as conduits but also in their role as catalysts, fostering interaction and cohesion between adjacent communities.

This detailed examination illuminates the multifaceted nature of integration within the urban landscape, underscoring the pivotal role played by certain axes in shaping the movement dynamics and fostering connectivity within and beyond individual neighborhoods. These findings lay the groundwork for informed urban planning strategies aimed at creating more cohesive, accessible, and well-connected urban environments that cater to the diverse needs and interactions of their inhabitants

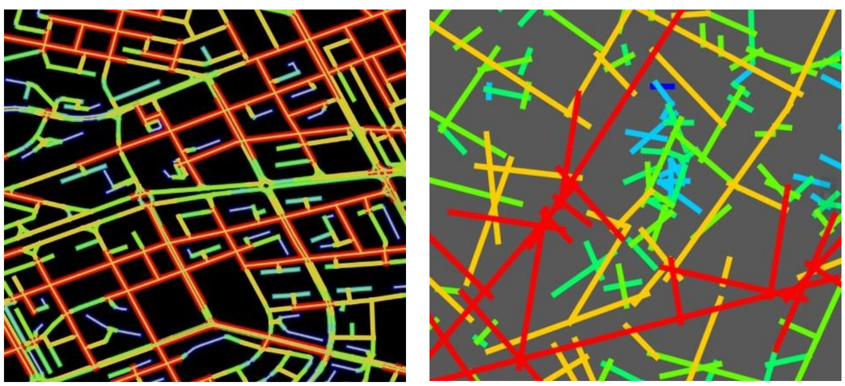


Figure 82 A Sample of the angular analysis.
Source: (Author 2022)

5. Pedestrian distribution

To address how people move in a dense urban area and by adopting appropriate measures which are sensitive to the spatial structure of street networks, we will explore in this study the movement behavior patterns related to syntactic attributes of Constantine’s urban areas. We will attempt to clarify the extent the street network design affects pedestrian distribution movement at the scale of the town and neighborhoods. In doing so, we tend to enrich the body of literature that scrutinizes the aspects of the relationship that link movement behavior to spatial configuration as the long-term framework that influences the evolution of urban function.

In our endeavor to unravel the intricate dynamics of how individuals navigate through densely populated urban environments, this study aims to delve deeper into understanding the movement patterns within Constantine's urban landscape. By meticulously examining and incorporating the spatial attributes embedded within the street networks, we seek to uncover the nuances of pedestrian movement behaviors prevalent in both the town and its various neighborhoods.

The crux of this exploration lies in elucidating the profound influence wielded by the design and layout of the street network on the distribution and flow of pedestrians. Our pursuit is not merely to comprehend the immediate impact but to unravel the subtleties that reverberate across the broader scale of the urban landscape. By peering into these intricacies, we aim to contribute substantially to the existing body of scholarly work dedicated to scrutinizing the intricate relationship that binds movement behavior to the spatial configuration.

This study's significance lies in its aspiration to bridge the gap between theoretical understanding and practical implications, shedding light on how the design nuances of street networks contribute to shaping the movement patterns within urban spaces. It seeks to ascertain the extent to which spatial configurations influence the trajectories of pedestrian movement and how this, in turn, shapes the evolution of urban functionality over the long term.

As we embark on this scholarly journey, our goal extends beyond academic inquiry. We endeavor to enrich the foundational knowledge that informs urban planning paradigms, policy formulations, and design interventions. By deciphering the intricate interplay between spatial configurations and pedestrian behaviors, we aim to offer actionable insights that pave the way for more efficient, accessible, and sustainable urban environments.

In essence, this study acts as a conduit, channeling our efforts towards a deeper understanding of the symbiotic relationship between the built environment and pedestrian movement. It stands as a testament to our commitment to unlocking the secrets embedded within the spatial structures of urban landscapes, fostering a future where cities are not just functional spaces but vibrant, inclusive hubs that cater to the diverse needs of their inhabitants.

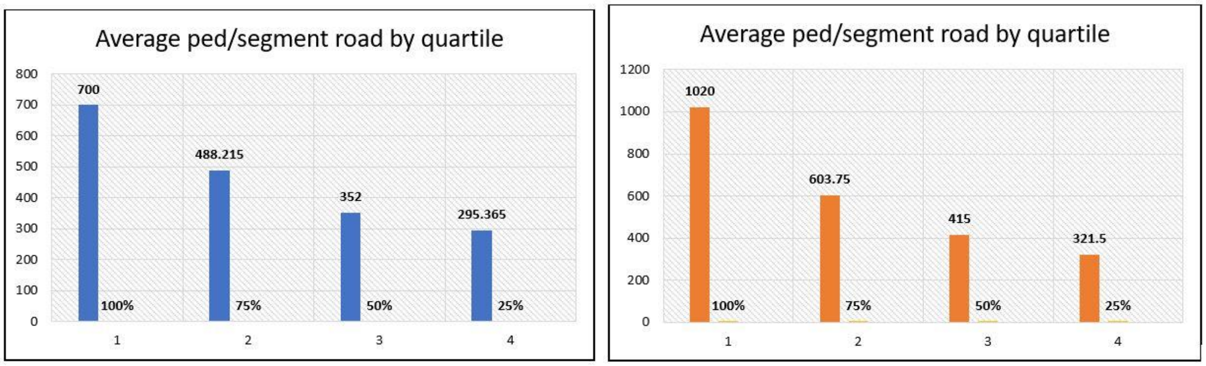


Figure 83 The average movement by quartile. (Author 2022)

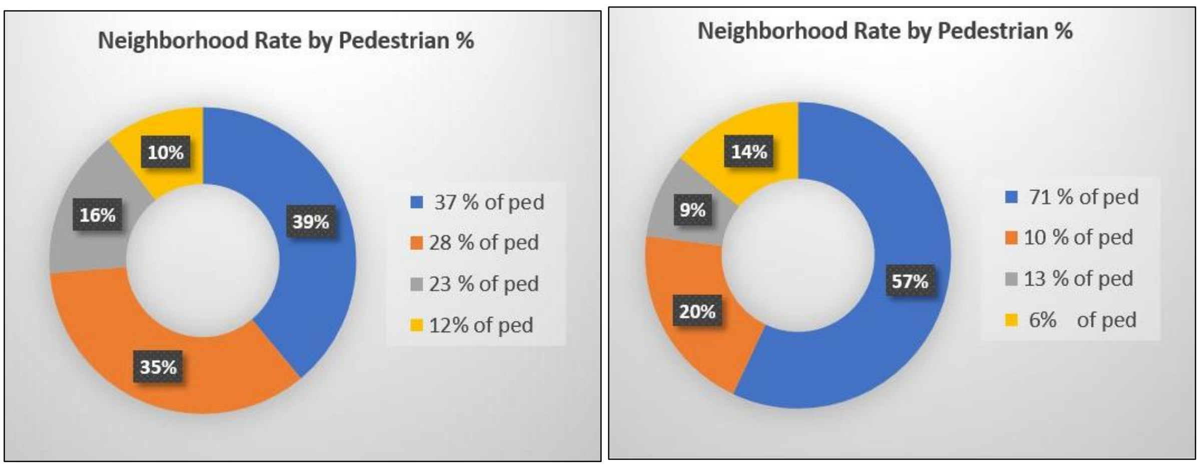


Figure 84 Neighborhood rate by movement rate. (Author 2022)

Figure 85 The observed movement
Source: (Author, 2022)

In our pursuit of a comprehensive understanding of the phenomenon under investigation, we have meticulously analyzed various crucial variables that intricately contribute to delineating the intricate tapestry of movement patterns within urban landscapes. Among these variables, measures such as choice and integration stand paramount, offering invaluable insights into the depiction of pedestrian movement behaviors.

Throughout our exploration, a myriad of nuances and disparities in results have surfaced across different levels and locations within the urban expanse. These disparities manifest vividly when contrasting the movement dynamics between distinct areas, such as the contrasting axes of the old town versus those of the new town.

In the context of the old town, the axes display a remarkable vibrancy, showcasing a bustling and continuous flow of movement, even within the winding and narrow streets. This phenomenon highlights the inherent liveliness and inherent dynamism ingrained within the spatial layout of the old town's street networks. Conversely, when examining the new town, our findings have validated a starkly different narrative. Here, the results indicate a significant contrast, elucidating that movement along the long and straight boulevards registers notably lower levels of activity, particularly outside of peak rush hours.

This divergence in movement patterns between the old and new town areas serves as a compelling testament to the intricate interplay between spatial design and pedestrian behaviors. It underscores how the urban form, characterized by winding streets in the old town and long boulevards in the new town, profoundly influences the dynamics of pedestrian movement.

The disparities uncovered through our meticulous analysis offer profound insights into the underlying intricacies governing pedestrian behavior within distinct urban contexts. It serves as a pivotal foundation upon which future urban planning strategies can be formulated to create more inclusive, vibrant, and efficient urban spaces.

As we navigate through these complexities, our dedication remains steadfast in unraveling the layers that govern the movement dynamics within urban environments. Through this pursuit, we aim not only to enhance our understanding of these intricate phenomena but also to pave the way for informed interventions that optimize urban spaces for the benefit and well-being of their inhabitants.

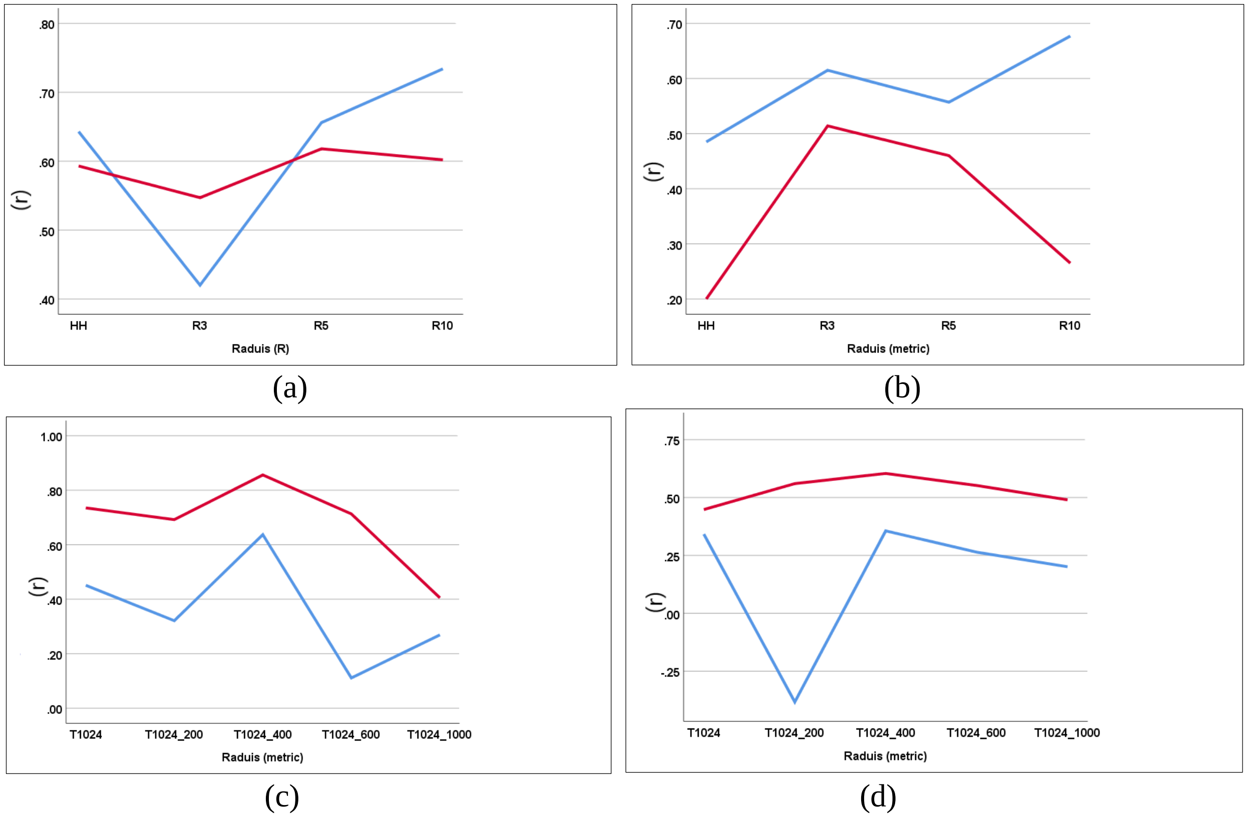


Figure 86 correlation across the scale.
Source: (Author, 2022)

The intricate interplay between pedestrian movement and the angular and topological configuration parameters within urban landscapes stands as a fascinating study that unveils the nuanced distinctions discernible across various city types. Delving into this exploration, distinct patterns emerge, shedding light on the divergent relationships that these parameters exhibit in different urban settings.

One notable revelation surfaces when contrasting the old town with the new town: the correlations between angular features and pedestrian volume showcase stark disparities. In the precincts of the old town, these correlations stand out prominently, demonstrating a robust relationship between angular attributes and the volume of pedestrian traffic. This phenomenon underscores the profound influence wielded by the angular configuration within the spatial layout of the old town, shaping the movement dynamics and pathways traversed by pedestrians.

Conversely, within the realms of the new town, the correlations between angular features and pedestrian volume paint a notably different picture. Here, these correlations exhibit a comparative reduction in their significance, implying a less pronounced relationship between angular attributes and pedestrian movement compared to their counterparts in the old town. This divergence accentuates the distinct urban design paradigms prevalent in the new town, where the impact of angular features on pedestrian movement appears to be relatively subdued compared to the older, more intricately woven urban fabric.

Furthermore, a compelling parallel emerges as the metrics, especially the angular Integration and Choice qualities, exhibit a noteworthy connection with pedestrian volume in a manner akin to the findings gleaned from the initial section of this comprehensive study. This reaffirms the inherent significance of these particular metrics in delineating the intricate relationship between urban configuration and pedestrian behavior, transcending the boundaries of city typologies.

These nuanced observations underscore the multifaceted nature of urban dynamics, illustrating how the interplay between angular and topological parameters varies across different urban settings. By decoding these intricate relationships, this study aims to lay the groundwork for informed urban planning strategies that optimize the built environment to accommodate pedestrian needs, fostering vibrant, accessible, and inclusive urban spaces tailored to the diverse demands of inhabitants across various city typologies..

Figure 87 Old town streets are busy along the week
Source: (Author, 2022)

Figure 88   Pictures taken from Eressif
Source: (Author, 2022)

the findings show that the old town, characterized by its winding and labyrinthine streets, serves as a testament to the rich tapestry of urban design that fosters a positive, vibrant, and dynamic environment conducive to movement and accessibility. These meandering pathways, intertwined in a seemingly intricate maze, contribute significantly to the allure and vibrancy of the old town.

One of the distinctive hallmarks of the winding streets lies in their ability to stimulate movement and activity. The convoluted nature of these pathways instigates an organic flow, inviting pedestrians to explore and engage with the urban fabric. Far from being deterrents, the winding streets in the old town serve as catalysts for heightened pedestrian movement. Their sinuous nature encourages individuals to traverse the narrow alleys, prompting spontaneous interactions and fostering a sense of exploration and discovery.

Furthermore, the very design of these streets amplifies accessibility in unique ways. While appearing labyrinthine, these winding pathways often conceal hidden gems, be it quaint cafes tucked away in secluded corners or artisanal boutiques nestled amidst the maze. This intricate layout, far from inhibiting accessibility, enhances it by creating pockets of interest and attracting foot traffic to explore various nooks and crannies.

Moreover, the winding streets evoke a sense of intimacy and coziness, fostering a vibrant tapestry of social interactions. The closeness of buildings, the twists and turns of the alleys, and the occasional surprises encountered around corners contribute to a lively atmosphere teeming with movement and human connection. These streets become conduits not just for movement but also for community engagement and cultural exchange.

The old town's winding streets, rather than posing obstacles, weave an intricate fabric that breathes life into the urban landscape. Their winding nature infuses the area with an undeniable charm, fostering a positive environment where movement, accessibility, and vibrancy thrive harmoniously. In essence, these streets embody the very essence of a dynamic urban space that beckons inhabitants and visitors alike to explore, discover, and revel in its vibrant energy.

Figure 89 The most of the city's arteries are car-oriented.
Source: (Author 2022)

Figure 90 Attempts to set up spaces to promote walking
Source: (Author 2022)

Figure 91 Within UVs-type neighborhoods, walking areas. Source: (Author 2022)

Figure 92 Streets in Ali Mendjely's UVs are deserted
Source: (Author, 2022)

In contrast to the winding and vibrant streets of the old town, the new town often exhibits a different urban layout that prioritizes large, straight streets and routes. While this design may serve vehicular traffic efficiently, it often detracts from the prominence of pedestrian movement and accessibility within the urban fabric.

The predominant feature of large, straight streets in the new town tends to create an environment that is more car-oriented than pedestrian-friendly. These expansive thoroughfares, while facilitating vehicular flow, tend to prioritize speed and efficiency for automobiles, often at the expense of walkability and pedestrian movement. The emphasis on wide, linear roads may inadvertently discourage pedestrian activity, as the vast stretches between destinations might seem less inviting or challenging to navigate on foot.

This car-centric design approach within the new town might hinder the organic flow and vibrancy typically associated with pedestrian-friendly urban areas. The lack of intricacies and winding pathways that encourage exploration and spontaneity in movement could potentially limit the opportunities for social interaction and community engagement.

To enhance the walkability and accessibility of the new town, a reimagining of urban design principles might be essential. Implementing strategies that prioritize pedestrians, such as introducing narrower, more meandering streets or creating pedestrian-friendly zones, could revitalize the area. Incorporating features like green spaces, sidewalk cafes, and mixed-use developments could foster a sense of place and encourage people to linger, explore, and interact.

Furthermore, adopting measures such as traffic calming initiatives, designated pedestrian pathways, and improved connectivity between destinations can shift the focus from vehicular dominance to a more balanced and people-centric approach. Creating a human-scale environment that promotes walking and cycling while ensuring safety and convenience can greatly enhance the appeal and livability of the new town.

Ultimately, a thoughtful redesign that prioritizes walkability and accessibility in the new town can transform it into a vibrant, pedestrian-friendly space. By reimagining the urban landscape to cater more inclusively to pedestrians, the new town can evolve into a dynamic, engaging environment that fosters movement, social interaction, and a sense of community for its inhabitants.

The findings support the previous research (Siksna, 1998) about historically grown towns, the shape of the urban grain optimizes itself to increase the proximity between activities and people. Following the distribution of population densities, block sizes become smaller, whereas a higher degree of urban activity is required, the higher permeability of the urban blocks facilitates the browsing and navigation needed for a mixed used area, the movement flows are channelled into a number of streets, which become reasonably well-used and adequately safe. The opposite is the case of the most new towns. Whereas urban blocks in the town centers are not small enough to facilitate navigation and browsing, urban blocks in the residential zones are disproportionately large and space is so fragmented that the relatively low movement levels generated by residential uses are distributed across many more streets. This dilution of movement leads to very low levels of co-presence between pedestrians and thus to a perception of a lack of safety in residential areas.

6. Conclusion

Space syntax approaches hold a lot of promise as a simple way to measure characteristics of urban form in relation to walking. We concentrated on the space syntactic theory of natural movement in our thesis, and we investigated new research pathways that may be opened up by using this theory. Natural movement can give insights into street layout as a multidimensional factor of walking because it allows urban design and urban function to be linked with pedestrian movement as an underlying element. Although space syntax has been utilized for decades in urban design/planning, architecture, transportation, and geography, its application to health promotion by walking is currently restricted. Further research is needed to make more explicit use of natural movement theory and to use space syntactic methodologies to guide urban design/planning practices and policies that favor walking for transportation.

Pedestrian volume as a design input for pedestrian facilities is gaining traction in policy and planning circles. In our study we have investigated the movement trough two spatially and historically different urban areas, the old and the new town of Constantine city. Knowledge on the distribution of pedestrian movement volumes over the street network is critical for urban environment planning and design, particularly in the establishment and maintenance of livable and sustainable urban centers. Using network analysis models, pedestrian volume was built primarily within the conceptual and methodological framework of the space syntax approach.

The findings corroborate the basic hypothesis: street network and built environment characteristics are clearly related to the proportion of people who walk in cities. They also demonstrate the importance of a previously unexplored variable in the field of mobility studies based on Space Syntax theory which is the configurational accessibility of the street network in the case of the walking behavior in Constantine area.

According to the research, street networks include systematic structural qualities that represent the overlap between topological and angular centralities, as well as differential correlations between centralities of each distance type. When these linkages are characterized by angular rather than topological centrality measurements, these structural features improve the association of street network topology with simulated movement patterns. These findings, based on observable movement, assist to explain the prevalence of angular centralities in movement modeling that has been reported in the literature. The findings of the study also contribute to the debate over the influence of street network structure verses human spatial behavior on movement flows. They clarify that the structural qualities of the street network confer angular centrality supremacy with a degree of freedom in the distance type. In other words, this study establishes the existence of network effects and throws light on how they work: That is, network effects do more than just generate distinct forms of movement potentials; they also influence how these potentials are used as a result of their overlap and linkage.

Bivariate analysis verified street design as individual predictors of neighborhood-level walking excursions. The findings are of a different nature, but they appear to be consistent with studies that include configurational properties. They also agree with recent proposals that assume a similar type of relationship between both variables in their origin-destination weighted choice model for evaluating the impact of new urban developments. In conclusion, the findings suggest the necessity for further research into the street network as a unique component of the built environment. They demonstrate that including configurational accessibility improves comprehension of the street network, which is one of the urban design variables influencing pedestrian mobility.

Patterns of observed pedestrian movement flows also demonstrate significant differences between these two urban types. In the traditional town, pedestrian movement patterns follow the hierarchy of the spatial network, with a high number of pedestrians using the routes within the core of spatial accessibility. The zoning approach used in new towns typically leads to very high levels of pedestrian movement to be concentrated in a small section of the designated town center. Movement flows drop sharply from the town center onwards and are uniformly low in the rest of the town. This movement pattern is the consequence of extreme spatial and functional segregation. In many cases it is also caused by the segregation of modes of transport and the related low availability of pedestrian walkways. This results in a dramatic reduction of pedestrian flows in other parts of the urban realm and the consequential perception of a lack of safety, as mentioned above.

In conclusion, the study gave credit to the significant role of the spatial configuration of the built environment, embodied by the street network, as an important index in the study of movement, based on the observation of Hilliers's natural movement. Through a comparison between the old urban fabric and the new development of the new town, we have observed distinct differences in the way people navigate and interact within these spaces. By analyzing the accessibility, of both street networks we can gain insights into how they shape movement patterns. In the case of the old town, the complex street network influences pedestrian movement by providing a rich tapestry of interconnected paths and inviting people to traverse different routes. The new town's street network, on the other hand, tends to channel movement more directly, focusing on optimizing transportation efficiency.

While the new town's design may offer benefits such as improved traffic flow, we should acknowledge the value of the old town's organic development. Where the sinuous and winding street network not only preserves a historical character but also provides a sense of place and a more diverse and vibrant pedestrian experience. It is a testament to the wisdom of the past built environment experiences, where the shaping of streets was often driven by natural topography and evolved over time to cater to the needs of its inhabitants. Traditional urban fabrics, characterized by mixed-use buildings, and a close-knit layout, often reflect historical, cultural, and social aspects of a community. They encourage pedestrian movement, and create a human-scale environment, promoting physical activity, social interaction, and vibrant street life.

The studied new town street network provided us with a deep understanding of the actual situation and contributed to giving us insights into how the new development layout out design should be in the future. In fact, In the new town with a car-oriented design, the street network is typically designed to prioritize vehicular movement over pedestrian movement. The lack of accessibility may be caused by the Low Permeability this means that The street network is designed to limit the number of direct connections between different areas of the town, there are fewer streets and intersections, resulting in limited options for travel routes. This design discourages through movement and promotes local circulation, but it can also impede pedestrian movement and connectivity. The new town is characterized by a large block size, which means that the distance between intersections is greater compared to more walkable designs. Larger blocks can make it more challenging for pedestrians to navigate the town efficiently and can discourage walking as a mode of transportation. In such a layout design we can also highlight the limited pedestrian infrastructure due to the car-oriented focus, the provision of pedestrian infrastructure such as sidewalks, crosswalks, and pedestrian-friendly features is limited. This can make it less safe and appealing for pedestrians to navigate the town on foot. The zoning design pattern of the town has prioritized the separation of land uses, resulting in distinct areas dedicated to residential, commercial, and industrial purposes. This can lead to greater distances between destinations, making it less feasible for residents to walk or bike to various amenities, further reducing walkability. In the new town, the Lack of pedestrian amenities In the old town that encourage pedestrian activity, such as public parks, pedestrian plazas, or street furniture. Without these features, the environment becomes less conducive to pedestrian movement and reduces the overall walkability of the town.

It's important to note that a car-oriented design can have negative implications for community health, social interactions, and the environment. Many modern urban planning practices emphasize the importance of designing towns and cities that prioritize walkability, accessibility, and a mix of land uses to create more vibrant, sustainable, and livable communities.

Finally, we can deduce that Using old-town design inspiration to enhance walkability in new urban development can be a valuable approach. Old towns often exhibit characteristics that promote walkability, such as compact layouts, mixed land uses, pedestrian-friendly streets, and active public spaces. By incorporating these elements into new urban developments, you can create environments that are conducive to walking and promote a sense of community. Here are a few reasons why using old-town design inspiration can enhance walkability:

- Proven Pedestrian-Friendly Features: Old towns have evolved over time, with an urban fabric that was often designed before the dominance of automobiles. Their layouts and design elements were typically geared toward supporting pedestrian movement. By drawing inspiration from these proven pedestrian-friendly features, such as narrow streets, wide sidewalks, and mixed land uses, you can create an environment that encourages walking.

- Sense of Place and Identity: Old towns often possess a unique character and sense of place that can create a more enjoyable walking experience. Incorporating design elements and architectural styles from old towns can help establish a distinct identity for new urban developments. This can foster a sense of attachment and pride among residents, making them more likely to walk and engage with their surroundings.

- Historical Context and Cultural Significance: Old towns often have historical and cultural significance tied to their design. By understanding and respecting this context, you can integrate elements that preserve the heritage and charm of the area. This can create a more appealing environment for pedestrians, as they can appreciate the historical context while enjoying their walks.

- Enhancing Social Interaction: Old towns are often designed to foster social interaction and community engagement. Incorporating public spaces, plazas, and gathering areas into new urban developments can encourage people to come together, socialize, and interact. This can lead to stronger community ties and a greater likelihood of walking as people are drawn to these active and vibrant spaces.

- Learning from Successful Examples: Many old towns have stood the test of time and continue to be cherished for their walkability. By studying successful examples, you can gain insights into what design elements contribute to a pedestrian-friendly environment. Implementing these elements in new urban developments can help recreate the positive aspects of old town designs and improve walkability.

It's important to note that while drawing inspiration from old town designs is beneficial, it's also crucial to adapt and update these ideas to suit the needs and context of the present-day community. Balancing the preservation of heritage with the requirements of modern living is key to creating successful and walkable new urban developments.

In conclusion, accessibility measures play a crucial role in promoting walkability within the built environment. Walkability refers to the ease and convenience of walking within a neighborhood or urban area. By ensuring that spaces are accessible to pedestrians, communities can create environments that are more conducive to active transportation, healthier lifestyles, social interactions, and overall livability. By analyzing the urban configuration through space syntax, planners and designers can gain insights into the relationships between physical spaces and human activities, allowing for more informed decisions regarding the implementation of accessibility measures.

since urban policy in Algeria is based on the planning of new towns according to different programs and urban strategies considering accessibility during the earlier planning stages through designing a comprehensive road network will be a crucial step to ensuring efficient walkability, through a well-designed network of streets, pathways, and transportation infrastructure, accessibility can be guaranteed for all residents and visitors. It facilitates connectivity between different parts of the town, such as residential areas, commercial zones, educational institutions, and recreational spaces. It promotes inclusivity, supports sustainable transportation options, contributes to the creation of livable and thriving communities, and enhances the overall well-being of residents.

GENERAL CONCLUSION

1. General conclusion

Cities are places for accommodating various interactions. To understand the relationship between urban form and its functionality is one of the most challenging tasks in modern urban design against the background of a built environment, where we are living, that has been expanding at an unprecedented speed, faster than at any stage in the history of urbanization. It is argued in this thesis that social processes are highly complex, and the underlying interactions between the spatial and urban configuration centrality structures across scales characterize urban performance over time.

The unclear linkage between urban form dynamics and urban performance in Algerian cities, where the tension between form and function and between the new and old is increasingly significant. Modern urban design approaches allocate functions based on over-simplified geometrical logics, thereby separating citizens spatially and functionally, lowering the efficiency of the organization of urban potentials and resulting in a series of social problems. This trend fuels debate over whether and how urban design can be an instrument to upgrade the social functionality of urban contexts left behind by rapidly growing spatial grids. Aiming to address this question, new knowledge produced in the present thesis contributes to the improvement of the social effectiveness of urban design by illustrating the mechanisms by which spatial and functional centrality structures have social consequences. It is argued that socially functional urban design can hardly be made if people fail to quantify the urban spatial and functional contexts, particularly in fast-changing modern environments, where mismatch between form and function is more significant than in pre-modern environments. Therefore, designing more sustainable cities requires advanced knowledge of the interdependence between social performance in public spaces and the spatial-functional interaction within the larger spatial and functional backgrounds in which they are embedded.

In this thesis, it is contended that understanding the complexities of movement behavior interaction in a morphological analysis can enhance the efficiency of urban design and planning interventions, which aim to improve social conditions. It is more valuable for urban designers, planners and decision makers to understand the mechanisms by which observed urban changes are driven by the balance among the varying effects exerted by configurational circumstances, or other factors, and make spatial interventions transparent and tactical. It is also claimed in this research that urban design practices should pay attention to the locality of the mechanisms, in which the characteristics of urban performance and the social effects of centralities tend to be similar. Two essential prerequisites to making a good urban design scheme for one area are as follows: firstly, taking into consideration the contextual physical space and land-use patterns; and secondly, taking actions that suit the local circumstances identified by homogeneous impacts exerted by spatial and functional centrality structures and other significant factors.

Throughout this research, the adopted methods seeking to avoid assertive conclusions made based on correlation analyses and aggregate data. These efforts take a step toward the goal of empowering the approaches to assess specific plans for urban designers in practice with improved precision. They also provide a microscopic tool for the policy makers and other professionals to refine the regional policies into architectural spaces and to coordinate policies with design strategies aiming to maximize their effectiveness and efficiency across spaces in consideration of the spatial and functional contexts. Another essential feature of the introduced model is its compatibility and scalability with ubiquitous 'big' data emerging in the current digital society. Exploiting the advantages of quantitative modelling and visualization with urban big data allows one the opportunity to bridge configurational studies with socioeconomic research, on the theoretical side, and to encourage more inter-disciplinary communication, on the practical side. The models in the present study, through far from perfect due to some methodological and technical limitations, formulate a benchmark for future extensions focusing on exploring the configurational logics of social phenomena.

Our main research core in this thesis is turning around the Configurational accessibility which refers to the physical layout and design of the built environment that determines how easily people can move within a space or reach desired destinations. It encompasses factors such as street networks, connectivity, integration, choice and also proximity of amenities. In the context of old town and new town designs, configurational accessibility plays a crucial role in creating inclusive and easily navigable environments. Old towns, with their historical development patterns, often exhibit high configurational accessibility. The street networks are often well-connected, featuring narrow, winding streets that promote walkability and offer shorter travel distances between destinations. The compact layout of old towns allows for easy access to amenities, fostering a sense of convenience and community interaction. However, the lack of accessibility in the new town designs can be attributed to several factors related to the design and the built environment. The shortcoming in accessibility may be related to the fact that it was initially planned with a focus on accommodating cars rather than pedestrians. Wide roads, sprawling layouts, and an emphasis on parking creating barriers for pedestrians and individuals with mobility challenges, which results in longer walking distances, limited pedestrian infrastructure, and a lack of connectivity between different areas within the town. Also the adaptation of the land use separation in the design of the built environment led to the separation of land uses which were founded concentrated only in some urban units this can make it difficult for users to with limited mobility to access essential services, leading to a reliance on cars or transportation alternatives. While new town designs often incorporate pedestrian infrastructure, some of theme are not sufficient or poorly designed. Because of the lack of lack comprehensive community input during the planning process. When accessibility needs and concerns of diverse populations are not adequately considered, it can result in a built environment that does not cater to the needs of all residents.

This thesis creates a broader picture showing urban centrality structures hosting the movement. More precisely, it is argued that it is the spatio-functional interaction in the built environment which facilitates various aspects of the socioeconomic vitality from place to place and from time to time. The produced knowledge not only suggests a valuable extension of the current space syntax model, in which the functional centrality structures supplement spatial centrality patterns, but also indicates possible enhancements in the analyses of socioeconomic performance, which can be achieved by taking advantage of the methodologies established and verified in this thesis. The proposed methods can be new tools not only for urban designers but also for cross-disciplinary professionals to take a series of effective actions with the precision of fine-grained, intra-city detail.

In this thesis we come up to the following recommendations:

Walkability is a crucial aspect of new town design it focuses on creating pedestrian-friendly environments where residents can easily walk and access amenities without relying heavily on cars. In this thesis. The use of old-town design elements in new-town designs can be a tool to develop the walkability, this concept often referred to as "new urbanism" or "traditional neighborhood design." It involves incorporating architectural and planning elements inspired by historic towns and cities into contemporary urban development projects. The goal is to create more pedestrian-friendly, livable, and visually appealing communities that promote a sense of community and connectivity.

1. Mixed Land Use: old towns often incorporate a mix of residential, commercial, and recreational spaces within a compact area. This encourages walkability and reduces the need for extensive car usage.

2. Traditional Street Patterns: old towns may feature narrow, interconnected streets with a grid or a winding pattern that promotes slower vehicle speeds and enhances the pedestrian experience. They often prioritize sidewalks and street trees to create an inviting environment.

3. Human Scale and Proportions: Old town design emphasizes buildings and public spaces that are proportionate to human scale, creating a sense of intimacy. New town designs seek to replicate this by ensuring buildings are not overly massive and that public spaces are inviting and comfortable.

4. Public Spaces and Plazas: Open public spaces, squares, and plazas are common features in old towns. These areas serve as gathering places, where people can socialize, relax, and participate in community events. New town designs often incorporate similar public spaces to foster social interaction.

5. Accessible Amenities: New towns influenced by old town design should prioritize accessible amenities within walking distance. This includes schools, parks, shops, and other essential services to reduce the dependence on cars and promote a sense of community.

6. Active Design Principles: Walkable new towns should incorporate active design principles that promote physical activity and active living. This includes incorporating features like staircases on the image of the old towns, attractive walking routes, and bike-sharing roads, encouraging residents to incorporate exercise into their daily routines.

7. Complete streets are integral to walkable new towns. Complete streets should be designed to accommodate all users, including pedestrians, cyclists, and motorists. They feature wide sidewalks, bicycle lanes, tree-lined streets, and traffic calming measures that prioritize the safety and comfort of pedestrian.

8. Green Spaces and Public Plazas: Walkable new towns should incorporate ample green spaces, parks, and public plazas. These areas provide opportunities for recreation, relaxation, and social interaction. Accessible and inviting public spaces encourage people to walk, explore, and spend time outdoors.

9. Safety and Security: Ensuring the safety and security of pedestrians is essential for walkable new towns. Design considerations such as well-lit pathways, clear signage, traffic calming measures, and surveillance systems help create a safe walking environment, encouraging residents to choose walking as a preferred mode of transportation.

By integrating these elements, new town designs inspired by old town design aim to create vibrant, sustainable, and people-centered communities that evoke a sense of timelessness and community spirit.By prioritizing walkability in new town design, communities can foster healthier, more sustainable, and socially connected environments that reduce traffic congestion, improve air quality, and enhance the overall quality of life for residents.

In conclusion, walkability plays a vital role in both old town and new town designs. It is a key element that fosters pedestrian-friendly environments, promotes active lifestyles, and enhances the overall quality of life for residents. Old towns serve as inspiration for new town designs, with their traditional street patterns, human-scale architecture, and accessible amenities. By incorporating these elements into new town designs, along with additional features like mixed-use development, pedestrian infrastructure, and green spaces, communities can create vibrant and sustainable environments that prioritize the needs of pedestrians. Walkable new towns not only reduce reliance on cars but also encourage social interaction, create healthier living environments, and contribute to a sense of community and connectivity among residents.

2. Limitations of the study

Although this study has used a large amount of data, issues regarding lack of data availability persist. Specifically, the weights of urban amenities on the supply side are simplified to be the same, indicating that the service capability of land-uses is even. Nevertheless, the place popularity for all the historic land-use locations is assumed to be even due to the absence of information regarding the popularity of urban activities. Richer analyses of the movement patterns may be extracted in the future when more data become available. In addition, the proposed analyses of socioeconomic performance can be further validated with the historical socioeconomic data, aiming to illustrate the temporal causality in the detected interrelationship between centrality structures and spatial performance.

Throughout its analyses, this thesis has employed rigorous correlation models to quantify the causal relationships found. In fact, the interpretation of the causality in the relationship between the independent and dependent variables is conditioned by the data quality and the methodological limitations. As a consequence, the correlation modeling approaches used in this study can be enhanced to discover the underlying causality in the found correlations. Firstly, other variables with solid propositions in relevant theory could be added to the configurational variables into the models so that the essential impacts of the factors representing the built environment configuration might be confirmed further. In other words, the introduced methods in this thesis can be further validated though a comparison to conventional methods that combine land-use factors and centrality variables. Furthermore, the autocorrelation between the centrality variables at the proximal radii results in significant degrees of circular causation in the proposed models. This phenomenon demonstrates how difficult it is to anticipate the outcome of altering the value of a variable.

To avoid the awkward situation in which the simultaneous influence of two related variables on a third variable is not additive, interaction terms indicating the combined effects of several variables can be considered for addition in correlation models, with the goal of accounting for the moderated effects of the explanatory variables. Simultaneously, the introduced centrality variables can be used as the inputs in more advanced models to produce additional insights into the spatial strength for the social (re)productions. For instance, methods of structural equation modeling, including confirmatory factor analysis, path analysis, and the like, can be adopted to assess the unobservable 'latent' constructs among variables. In these models, the hidden hierarchical structures of the dependent variables can be illustrated.

3. Further research and perspectives

This study shows that an urban configuration dataset has an effective implication on the movement behavior of people. One key methodological development is producing temporal descriptions of urban spatial structures. This effort has symbolic significance on the morphological analysis, and the space syntax research in particular, as the conventional morphological portrayals are typically static, lacking the capability to illustrate short-term transformation. With the increasing availability of volunteered geographical information with temporal variations in social media, the proposed methods of measuring the urban function connectivity patterns can be advanced to the temporal version to represent the 'live' analysis of the spatial structures. This improved method will extend our current knowledge of the spatial configuration to a finer time scale, from years to days, and even hours, if relevant data are available. Despite that urban design normally serves long-term developmental aims, computing the spatiotemporal urban function connectivity metrics can illuminate the immediate effects that proposed design plans and strategies will bring to the urban context. This aim can be achieved by adding information regarding time-related accumulated check-ins for all the land-use locations in the research framework of this study. Future efforts addressing time-based planning issues, for example, making the roads safer at night, can take the movement inside any configuration more efficient.

REFRENCES

Ajzen, I. (2005). EBOOK: Attitudes, Personality and Behaviour. McGraw-hill education (UK).

Akcura, T. (1971). Ankara: a monographic study. Middle East Technical University Publications, 16, 1970–1990.

Al-Attar, I. (2018). Baghdad: An Urban History Through the Lens of Literature. Routledge.

Alexander, C. (1965). A city is not a tree. Ekistics, 139, 344–348.

Alexander, C. (1977). What is a pattern? Language, New.

Alonzo, É. (2018). L'architecture de la voie: histoire et théories. École d'architecture de la ville & des territoires.

Alsayyad, N. (2014). Medievalurbanism:Citiesfrom the ArabIslamic world. In D. E. Cosgrove (Ed.), Mappings (Vol. 7, pp. 285-304). Reaktion Books.

Altman, I. (1975). The environment and social behavior: privacy, personal space, territory, and crowding.

Appleyard, D. (1981). Livable streets. University of California Press.

Approfondissement théorique : les fondements esthétiques de la composition d'une place (C. Sitte). | Espaces publics places. (n.d.). Retrieved February 10, 2023, from https://unt.univ-cotedazur.fr/uoh/espaces-publics-places/approfondissement-theorique-les-fondements

BAKIRI, R. (2011). Impact De L ' Intervention Coloniale Sur.

Bafna, S. (2003). Space syntax: A brief introduction to its logic and analytical techniques. Environment and Behavior, 35(1), 17–29.

Barles, S. (2000). L'essor de la circulation à Paris au cours du premier XIXe siècle: quantification, réponses techniques et réglementaires.

Batty, M. (2005). Cities and complexity: Understanding cities with cellular automata, agent-based models, and fractals. MIT Press.

Bekkering, H. C. (2006). Morphological Analysis of the Contemporary Urban Territory: Is it still a relevant approach. Hoeven F van Der &Rosemann HJ, Urban Transformations and Sustainability, IOS Press, Delft, 96–113.

Bell, A. C., Ge, K., &Popkin, B. M. (2002). The road to obesity or the path to prevention: motorized transportation and obesity in China. Obesity Research, 10(4), 277–283.

Ben-Joseph, E. (1995). Changing the residential street scene: Adapting the shared street (woonerf) concept to the suburban environment. Journal of the American Planning Association, 61(4), 504–515.

Benedikt, M. L. (1979). To take hold of space: isovists and isovist fields. Environment and Planning B: Planning and Design, 6(1), 47–65.

Benevolo, L. (1980). The history of the city. MIT Press.

Boeing, G. (2019). Street Network Models and Measures for Every U.S. City, County, Urbanized Area, Census Tract, and Zillow-Defined Neighborhood. Urban Science, 3(1), 28. https://doi.org/10.3390/urbansci3010028

Borie, A., Micheloni, P., & Pinon, P. (2008). Forma y deformación. De los objetosarquitectónicos y urbanos (Vol. 15). Reverté.

Brayley, E. W., Britton, J., &Brayley, E. W. (1850). A Topographical History of Surrey (Vol. 3). G. Willis.

Bretagnolle, A., & Robic, M.-C. (2005). Révolution des technologies de communication et représentations du monde: 1. Monde-point et monde difforme (années 1830-1840). L'information Géographique, 69, 150–167.

Bridge Street Corridor Plan Ohio. (n.d.). Retrieved February 14, 2023, from https://www.goodyclancy.com/projects/bridge-street-corridor-plan/

Buliung, R. N., &Kanaroglou, P. S. (2006). Urban form and household activity-travel behavior. Growth and Change, 37(2), 172–199.

Caniggia, G. (1963). Lettura di unacittà: Como.

Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. Journal of Urban Technology, 18(2), 65-82.

Carlota Marijuan — The Death and Life of Great American Cities (Jane... (n.d.). Retrieved February 10, 2023, from https://carlotamarijuan.tumblr.com/post/

Carmona, M. (2021). Public places urban spaces: The dimensions of urban design. Routledge.

Cataldai, G., Maffei, G. L., & Vaccaro, P. (2002). SaverioMuratori and the Italian school of planning typology. Urban Morphology, 6(1), 3–14.

Cataldi, G. (1998). Designing in stages: theory and design in the typological concept of the Italian school of SaverioMuratori. Typological Process and Design Theory, 35–54.

Cataldi, G. (2003). From Muratori to Caniggia: the origins and development of the Italian school of design typology. UrbanMorphology, 7(1), 19–34.

Cherif, I. (2021). Création d'un espace éco-commercial pour une smart zone diversifiée et efficiente Cas de l'UV 13 Est-AliMendjeli-Constantine. Université Salah Boubnider, Constantine 3.

Choay, F. (1965). L'urbanisme. Utopie et Réalité. Paris: Éditions Du Seuil.

Cité idéale de Chaux — Wikipédia. (n.d.). Retrieved February 12, 2023, from https://fr.wikipedia.org/wiki/Cité_idéale_de_Chaux

Cohen, R. (2013). The development of spatial cognition. Psychology Press.

Community Planning Utopias | Hendog's Crib. (n.d.). Retrieved February 14, 2023, from https://hendogscrib.wordpress.com/community-

Conzen, M. P. (1977). The maturing urban system in the United States, 1840–1910. Annals of the Association of American Geographers, 67(1), 88–108.

Conzen, M. P. (1978). Analytical approaches to the urban landscape. Dimensions of Human Geography. Chicago: University of Chicago, 128–165.

Conzen, M. P. (2001). The study of urban form in the United States. Urban Morphology, 5(1), 3–14.

Cook, T. D., Campbell, D. T., &Shadish, W. (2002). Experimental and quasi-experimental designs for generalized causal inference. Houghton Mifflin Boston, MA.

Corbusier, L. (1963). Manière de penser l'urbanisme (Vol. 2). Gonthier.

Corbusier, L., &Jenger, J. (2002). Le Corbusier: choix de lettres. Springer Science & Business Media.

Corsini, M. G. (2003). Building types and urban fabric of Rome's outer suburbs: From reading to planning. In Suburban Form (pp. 148–176). Routledge.

Courtat, T., Gloaguen, C., &Douady, S. (2011). Mathematics and morphogenesis of cities: A geometrical approach. Physical Review E, 83(3), 36106.

Crane, R. (1996). On form versus function: Will the new urbanism reduce traffic, or increase it? Journal of Planning Education and Research, 15(2), 117–126.

Cugurullo, F. (2018). Climate change and the symbolic violence of urban planning. Environment and Planning E: Nature and Space, 1(3), 347-363.

Cugurullo, F. (2018). Urban theory and the urban experience: Encountering the city. Routledge.

Cullen, G. (2012). Concise townscape. Routledge.

Darin, M. (1998). The study of urban form in France. Urban Morphology, 2(2), 63–76.

De Certeau, M., &Rendall, S. F. (2004). from The Practice of Everyday Life (1984). The City Cultures Reader, 3, 266.

Dictionary, O. E. (1989). Oxford english dictionary. Simpson, Ja & Weiner, Esc, 3.

Duany, A., Plater-Zyberk, E., & Speck, J. (2000). Suburban nation: The rise of sprawl and the decline of the American dream. North Point Press.

Duany, A., Plater-Zyberk, E., & Speck, J. (2000). Suburban nation: The rise of sprawl and the decline of the American dream. North Point Press.

Ensemble de 84 logements au quartier du Colvert - Pierre Bernard. (n.d.). Retrieved February 14, 2023, from https://pierrebernard-architectes.com/projets/ensemble-de-84-

Evans, G., &Larkham, P. J. (2004). Designing and living in a new industrial suburb: experiences in the Cannock Chase coalfield from the 1950s to the 1970s. Environment and Planning B: Planning and Design, 31(5), 673–691.

Ewing, R., &Cervero, R. (2010). Travel and the built environment. Journal of the American Planning Association, 76(3), 265-294.

Fortier, B. (1989). La métropoleimaginaire: un atlas de Paris. Editions Mardaga.

Forty, A., & Forty, A. (2000). Words and buildings: A vocabulary of modern architecture (Vol. 268). Thames & Hudson London.

Foucault, M. (1997). Space, knowledge and power (interview with Paul Rabinow). Rethinking Architecture: A Reader in Cultural Theory, 367–380.

Freundschuh, S. M., &Egenhofer, M. J. (1997). Human conceptions of spaces: implications for GIS. Transactions in GIS, 2(4), 361–375.

Friedman, D., Parikh, N. S., Giunta, N., Fahs, M. C., & Gallo, W. T. (2012). The influence of neighborhood factors on the quality of life of older adults attending New York City senior centers: results from the Health Indicators Project. Quality of Life Research, 21, 123–131.

Fériel, C. (2016). Du local au transnational, puis au national. Les apports des archives de l'OCDE en histoire urbaine. Histoire@ Politique, 2, 158–170.

Gamper, M., Schönhuth, M., &Kronenwett, M. (2012). Bringing qualitative and quantitative data together: Collecting network data with the help of the software tool VennMaker. In Social networking and community behavior modeling: Qualitative and quantitative measures (pp. 193–213). IGI Global.

Gans, H. J. (1991). Baron Haussmann and the aesthetic of urbanism. Critical Inquiry, 18(4), 701-722.

Gans, H. J. (1991). Urban identities in Northern Europe. Transaction Publishers.

Gehl, J. (2013). Cities for people. Island press.

Gehl, J., & Mortensen, L. (2001). Livet mellemhusene.

Google Maps. (n.d.). Retrieved February 26, 2023, from https://www.google.fr/maps/@28.0948734,.666194,5z

Grasland, C., Rebah, M. Ben, Mathian, H., Sanders, L., Lambert, N., Madelin, M., Charlton, M., Cheng, J., Fotheringham, S., & Holm, E. (2006). The modifiable areas unit problem. ESPON| Inspire Policy Making with Territorial Evidence.

Gyug, R. (1996). Urban planning in Renaissance Italy. Yale University Press.

Gyug, R. (1996). Urbanism and urbanization in the Roman Empire. In J. W. Eadie (Ed.), The Cambridge ancient history (Vol. 11, pp. 753-787). Cambridge University Press.

Harvey, D. (2010). Social justice and the city (Vol. 1). University of Georgia press.

Haumont, A. (1993). La Mobilité intra-urbaine: rétrospective et prospective. Les Annales de La Recherche Urbaine, 59(1), 109–118.

Hayles, N. K. (1991). Chaos and order:Complexdynamics in literature and science. University of Chicago Press.

Healy, C. (1997). From the ruins of colonialism: History as social memory. CUP Archive.

Hillier, B. (1999). The hidden geometry of deformed grids: or, why space syntax works, when it looks as though it shouldn't. Environment and Planning B: Planning and Design, 26(2), 169–191.

Hillier, B. (2014). Spatial analysis and cultural information: the need for theory as well as method in space syntax analysis. E. Paliou, U. Lieberwirth y S. Polla (Eds.), 19–48.

Hillier, B., & Iida, S. (2005). Network and psychological effects in urban movement. International Conference on Spatial Information Theory, 475–490.

Hillier, B., Turner, A., Yang, T., & Park, H.-T. (2009). Metric and topo-geometric properties of urban street networks: some convergences, divergences and new results. Journal of Space Syntax Studies.

Hirtle, S. C., &Jonides, J. (1985). Evidence of hierarchies in cognitive maps. Memory & Cognition, 13(3), 208–217.

How behaviour science could inform urban design interventions to promote active school travel - Sustrans.org.uk. (n.d.). Retrieved February 10, 2023, from https://www.sustrans.org.uk/our-blog/research/all-themes/all/how-behaviour-science-could-

Huot, J.-L. (1997). Aux sources de l'urbanisme: le cas du Proche-Orient ancien. Collection Villes et Sociétés, 13–21.

Imane FANTAZI ;Hecham BERNIA ZEHIOUA. (2018). Les facteurs de l'echec des operations de conservation du patrimoine bati dans la vieille ville de constantine. Sciences &Technologie D, 48(2005), 107–118.

Jackson, K. T. (1987). Crabgrass frontier: The suburbanization of the United States. Oxford University Press.

Jacobs, J. (1961). The death and life of great American cities. Vintage Books.

Jakobsson, A. (2009). Experiencing landscape while walking (Vol. 2009, Issue 2009: 67).

Jane Jacobs — Blog — Dover, Kohl & Partners. (n.d.). Retrieved February 14, 2023, from https://www.doverkohl.com/

Jean, C., Patrick, C., Philippe, P., & CORDA, P. (1980). Lecture d'une ville: Versailles. Paris, Le Moniteur.

Johnson, S. (2002). Emergence: The connected lives of ants, brains, cities, and software. Simon and Schuster.

Kaplan, R., & Kaplan, S. (1989). The experience of nature: A psychological perspective. Cambridge university press.

Kennedy, I. (2019). Seattle Rental Ad Texts and Processes of Segregation.

Kielhofner, G., &Coster, W. J. (2017). Developing and evaluating quantitative data collection instruments. Kielhofner's Research in Occupational Therapy: Methods of Inquiry for Enhancing Practice, 274–295.

King, R. (2011). Reading Bangkok. University of Chicago Press Economics Books.

Klaasen, I. T. (2003). Knowledge-based design: developing urban & regional design into a science.

Kostof, S. (1991). The city shaped. Little, Brown and Company.

Lavedan, P. (1982). "L''" Urbanisme à l'époque moderne: 16e-18e siècles" (Vol. 13). Librairie Droz.

Le Goix*, R. (2006). Les gatedcommunities aux États-Unis et en France: une innovation dans le développement périurbain? Hérodote, 3, 107–137.

Le Plan Voisin, le corbusier – Recherche Google. (n.d.). Retrieved February 14, 2023, from https://www.google.com/search?q=:+Le+Plan+,+le+corbusier&sxsrf=AJOqlzW6NJo9J2

Lefebvre, H. (1974). La production de l'espace. L'Homme et La Société, 31(1), 15–32.

Lefebvre, H., Kofman, E., & Lebas, E. (1996). Writings on cities (Vol. 63). Blackwell Oxford.

Les voitures à Paris au XXème siècle – Paris ZigZag | Insolite & Secret. (n.d.). Retrieved February 14, 2023, from https://www.pariszigzag.fr/insolite/histoire-insolite-paris/les-voitures-a-paris

Lilley, K. D. (2012). Urban life in the Middle Ages, 1000–1450. Palgrave Macmillan.

Llewellyn Park | Creator: Davis, A. J.; Haskell, Llewellyn; … | Flickr. (n.d.). Retrieved February 12, 2023, from https://www.fr.com/photos/psulibscollections/5977635689

Lofland, L. H. (2017). The public realm: Exploring the city's quintessential social territory. Routledge.

Louf, R., &Barthelemy, M. (2014). How congestion shapes cities: From mobility patterns to scaling. Scientific Reports, 4, 5561.

Loukaitou-Sideris, A. (2019). Sidewalks: Conflict and negotiation over public space. MIT Press.

Loukaitou-Sideris, A. (2019). Sidewalks: Conflict and negotiation over public space. Routledge.

Loukaitou-Sideris, A., & Banerjee, T. (1998). Urban design downtown: Poetics and politics of form. University of California Transportation Center.

Lynch, K. (1964). The image of the city. MIT press.

Madanipour, A. (2013). Whose public space?: International case studies in urban design and development. Routledge.

Maffei, G. L. (2009). The historico-geographical approach to urban form. UrbanMorphology, 13(2), 133–135.

Magri, S., &Topalov, C. (1987). De la cité-jardin à la ville rationalisée Un tournant du projet réformateur, 1905-1925: Etude comparative France, Grande-Bretagne, Italie, Etats-Unis. Revue Française de Sociologie, 417–451.

Makhloufi, L. (2005). La ville nouvelle de Constantine. Entre procédures participatives et démocratie représentative. En Ligne: Http://Www. Unil. Ch/Files/Live//Sites/Ouvdd/File

Malverti, X., & Picard, A. (1989). Les villes coloniales fondées entre 1830 et 1870 en Algérie (II). Les tracés de ville et le savoir des ingénieurs du génie. Ministère de l'équipement et du logement/Bureau de la recherche ….

Map of Chandigarh, le corbusier – Recherche Google. (n.d.). Retrieved February 14, 2023, from https://www.google.com/search?q=Map+of+Chandigarh,+le+corbusier&sxsrf=AJOqlzWtLaBtrT4A9BVtaLSL7Y-

March, L., &Stiny, G. (1985). Spatial systems in architecture and design: some history and logic. Environment and Planning B: Planning and Design, 12(1), 31–53.

Marcus, L. (2002). Architectural knowledge and urban form: The functional performance of architectural urbanity.

Maria Kockelman, K. (1997). Travel behavior as function of accessibility, land use mixing, and land use balance: evidence from San Francisco Bay Area. Transportation Research Record, 1607(1), 116–125.

Marshall, S. (2004). Streets and patterns. Spon Press.

Martin, M. D. (2001). Returning to Radburn. Landscape Journal, 20(2), 156–175.

McDonald, J., Wise, M., & Harris, P. (2008). The health impacts of the urban form: a review of the reviews. Sydney, Centre for Health Equity Training, Research and Evaluation.

McDougall, W. (2015). An introduction to social psychology. Psychology Press.

Miegel, F. (1993). Values and lifestyles: structural change and the process of socialization. Medie-ochkommunikationsteori, Univ.

MiletengrecMilêtos - LAROUSSE. (n.d.). Retrieved February 12, 2023, from https://www.larousse.fr/encyclopedie/ville/Milet/133189

Mirmoghtadaee, M. (2006). A proposed method for the analysis of urban character.

Mokdad, A. H., Marks, J. S., Stroup, D. F., &Gerberding, J. L. (2004). Actual causes of death in the United States, 2000. Jama, 291(10), 1238–1245.

Mongin, O. (1996). À qui profite la grille culturaliste?Esprit (1940-), 220 (4, 33–37.

Montello, D. (1992). The geometry of environmental knowledge. Theories and Methods of Spatio-Temporal Reasoning in Geographic Space, 136–152.

Moore, G. T. (1979). Knowing about environmental knowing: The current state of theory and research on environmental cognition. Environment and Behavior, 11(1), 33–70.

Morphologieurbaine — Wikipédia. (n.d.). Retrieved February 9, 2023, from https://fr.wikipedia.org/wiki/Morphologie_urbaine

Moudon, A. V. (1987). Public streets for public use.

Moudon, A. V. (1997). Urban morphology as an emerging interdisciplinary field. Urban Morphology, 1(1), 3–10.

Moudon, A. V. (1998). The changing morphology of suburban neighborhoods. Typological Process and Design Theory, 141–157.

Mumford, L. (1961). The city in history: Its origins, its transformations, and its prospects. Harcourt Brace Jovanovich.

Mumford, L. (1961). The city in history: Its origins, its transformations, and its prospects. Harcourt, Brace & World.

Muratori, S. (1959). Studi per unaoperantestoriaurbana di Venezia. Palladio, 1959, 1–113.

Musterd, S., &Salet, W. (2003). Amsterdam human capital. Amsterdam University Press.

Neill, W. J. V. (1997). Memory, collective identity and urban design: The future of Berlin's Palast der Republik. Journal of Urban Design, 2(2), 179

New Urbanism: Plans That are Changing the Landscape of DFW » Dallas Innovates. (n.d.). Retrieved February 14, 2023, from https://dallasvates.com/new-urbanism-plans-that-are-changing-the-landscape-of-

Newman, L., & Waldron, L. (2012). Towards walkable urban neighbourhoods. Urban Sus-Tainability: Reconnecting Space and Place.

Nicholson, W., & Snyder, C. M. (2012). Microeconomic theory: Basic principles and extensions. Cengage Learning.

Orfeuil, J.-P. (2004). Transports, pauvretés, exclusions: pouvoir bouger pour s' en sortir. Ed. de l'Aube.

PINON, P., & MICHELONI, P. (1978). Parcellaire foncière et architecture urbaine. Métropolis.

Pagliara, F., Debbage, K., & Preston, J. (2015). Retail geography: Complexity theory and emerging retail spaces. Springer.

Panerai, P., Castex, J., Depaule, J.-C., & Samuels, I. (2004). Urban forms: the death and life of the urban block. Routledge.

Papayanis, N. (2004). Planning Paris before Haussmann. JHU Press.

Park, S. (2008). Defining, measuring, and evaluating path walkability, and testing its impacts on transit users' mode choice and walking distance to the station. University of California, Berkeley.

Pellegrino, P., Jeanneret, E. P., & Kaufmann, R. M. (2010). Infrastructures et modèles urbanistiques. Espaces et Sociétés, 6, 9–30.

Penn, A., &Croxford, B. (1997). Effects of street grid configuration on kerbside concentrations of vehicular emissions. Proceedings, First International Symposium on Space Syntax, University College London, London, 16–18.

Picon-Lefèbvre, V. (2000). Constuire la ville sur dalle: Maine-Montparnasse et la Défense: 1950-1975. Paris 1.

Plan of the Welwyn garden city – Recherche Google. (n.d.). Retrieved February 14, 2023, from https://www.google.com/search?q=Plan+ofwyn+garden+city&tbm=isch&ved=2ahUKEwi_

Portugali, J. (2005). Cognitive maps are over 60. Spatial Information Theory: International Conference, COSIT 2005, Ellicottville, NY, USA, September 14-18, 2005. Proceedings 7, 251–264.

Portugali, J., &Stolk, E. (2016). Complexity, cognition, urban planning and design. Post-Proceedings of the 2nd Delft International Conference. Switzerland: Springer.

Prouteau, F., Prouteau, F., &Gilot, C. (2013). Comment repenser nos places , centralités historiques remises en cause ? To cite this version : HAL Id : dumas-00905945 Diplôme d ' Ingénieur de l ' Institut Supérieur des Sciences Agronomiques ,.

Respati, W., Tonny, S., Galih, S. A., &Prakasa, W. T. (2020). Corporate Social Responsibility (CSR) Model in Improving the Quality of Green Open Space (GOS) to Create a Liveable City. Corporate Social Responsibility.

Reynaud, E., Navarro, J., Lesourd, M., &Osiurak, F. (2019). a review of neuroimaging data on tool use observation network. Neuropsychology Review, 29, 484–497.

Rodríguez, D. A., Khattak, A. J., &Evenson, K. R. (2006). Can new urbanism encourage physical activity?: Comparing a new Urbanist neighborhood with conventional suburbs. Journal of the American Planning Association, 72(1), 43–54.

Rohe, W. M. (2009). From local to global: One hundred years of neighborhood planning. Journal of the American Planning Association, 75(2), 209–230.

Rome.Urban plan of Sixtus V.c1588 | Some Key Terms: Felice P… | Flickr. (n.d.). Retrieved February 12, 2023, from https://www.flickr.com/photos/24364447073167679

Saelens, B. E., Sallis, J. F., Black, J. B., & Chen, D. (2003). Neighborhood-based differences in physical activity: an environment scale evaluation. American Journal of Public Health, 93(9), 1552–1558.

Samali, M., &Lekehal, A. (2017). Les Espaces publics en tant que lieux de manifestation des faits urbains, cas de<< la ville nouvelle Ali Mendjeli.

Siksna, A. (2006). The study of urban form in Australia. Urban Morphology, 10(2), 89–100.

Sitte, C. (1889). City planning according to artistic principles. In Camillo Sitte: The birth of modern city planning (pp. 129–332).

Southworth, M., & Ben-Joseph, E. (2003). Streets and the shaping of towns and cities. Island Press.

Stamps III, A. E. (2003). Permeability and environmental enclosure. Perceptual and Motor Skills, 96(3_suppl), 1305–1310.

Stamps III, A. E. (2004). Mystery, complexity, legibility and coherence: A meta-analysis. Journal of Environmental Psychology, 24(1), 1–16.

Stamps III, A. E. (2010). Slines, entropy, and environmental exploration. Environment and Planning B: Planning and Design, 37(4), 704–722.

Stamps III, A. E., & Krishnan, V. V. (2006). Spaciousness and boundary roughness. Environment and Behavior, 38(6), 841–872.

Stevens, A., & Coupe, P. (1978). Distortions in judged spatial relations. Cognitive Psychology, 10(4), 422–437.

Stone, R. C. J. (2001). From Tamaki-Makau-Rau to Auckland: A History of Auckland. Auckland University Press.

Talen, E., & Ellis, C. (2002). Beyond relativism: Reclaiming the search for good city form. Journal of Planning Education and Research, 22(1), 36–49.

The 10 Best Cities to Live In (2016) - Metropolis. (n.d.). Retrieved February 10, 2023, from https://metropolismag.com/viewpoints/the-best-cities-to

Thiis-Evensen, T., &Kolbjøn, N. N. (1999). Archetypes of Urbanism a Method for the Esthetic Design of Cities.

Trancik, R. (1991). Finding lost space: theories of urban design. John Wiley & Sons.

Tschumi, B. (1996). Architecture and disjunction. MIT press.

Tverksy, B. (2018). Levels and structure of spatial knowledge. In Cognitive Mapping (pp. 24–43). Routledge.

Tversky, B. (2005). Cognitive maps, cognitive collages, and spatial mental models. Spatial Information Theory A Theoretical Basis for GIS: European Conference, COSIT'93 Marciana Marina, Elba Island, Italy September 1922, 1993 Proceedings, 14–24.

Uttal, D. H., Friedman, A., Hand, L. L., & Warren, C. (2010). Learning fine-grained and category information in navigable real-world space. Memory & Cognition, 38(8), 1026–1040.

Webber, M. M., &Wurster, C. B. (1963). Cities and Space: The Future Use of Urban Land; Essays from the Fourth RFF Forum. Johns Hopkins University Press.

Wells, N. M., & Yang, Y. (2008). Neighborhood design and walking: a quasi-experimental longitudinal study. American Journal of Preventive Medicine, 34(4), 313–319.

Werner, C. M., Brown, B. B., &Gallimore, J. (2010). Light rail use is more likely on "walkable" blocks: Further support for using micro-level environmental audit measures. Journal of Environmental Psychology, 30(2), 206–214.

White, D. F., &Crimmins, T. J. (1976). Urban Structure, Atlanta. Journal of Urban History, 2(2), 231–252.

White, D. R., &Borgatti, S. P. (1994). Betweenness centrality measures for directed graphs. Social Networks, 16(4), 335–346.

Whitehand, J. W. R. (2001). British urban morphology: theConzenion tradition. Urban Morphology, 5(2), 103–109.

Whitehand, J. W. R., & Morton, N. J. (2006). The fringe-belt phenomenon and socioeconomic change. Urban Studies, 43(11), 2047–2066.

Wilaya de Constantine. (n.d.). Retrieved February 24, 2023, from https://fr-academic.com/dic.nski/1733497

Xiao, Y., & Xiao, Y. (2017). Space Syntax Methodology Review. Urban Morphology and Housing Market, 41–61.

Xing, W., &Ghorbani, A. (2004). Weighted pagerank algorithm. Proceedings. Second Annual Conference on Communication Networks and Services Research, 2004., 305–314.

amesterdam, place – Recherche Google. (n.d.). Retrieved February 13, 2023, from https://www.google.com/search?q=amesterdam%2C+place+&tbm=isch&ved=2ahUK

yJAntoni, J.-P. (2016). Concepts, méthodes et modèles pour l'aménagement et les mobilités: l'aide à la décision face à la transition éco-énergétique. Economica.

grand ensemble , rue – Recherche Google. (n.d.). Retrieved February 13, 2023, from https://www.google.com/search?q=grale+%2C+rue+&tbm=isch&ved=2ahUKEwiw3bDd2pL9AhU9nCcCHQT6AbMQ2-

mental map ;kevin lynch – Recherche Google. (n.d.). Retrieved February 10, 2023, from https://www.google.com/search?q=mental+map+;+kevin+lynch&tbm=isch&hl=fr&nfpr=1&sa=X&ved=2ahUKEwiPp6TMkIvQBXoECAEQIw&biw=1263&bih=503

urbanistica, C. studi di storia, Muratori, S., Bollati, R., Bollati, S., &Marinucci, G. (1964). Studi per unaoperantestoriaurbana di Roma. Consiglionazionaledellericerche.

van Eldijk, J., Andersson, L., Pettersson, P., & Koch, D. (2014). TrygghetsutredningNoltorp. Gøteborg: Rambøll.

ville nouvelle de constantine – Recherche Google. (n.d.). Retrieved February 24, 2023, from https://www.google.com/search?q=ve+e&tbm=isch&ved=2ahUKEwjrrre22K79AhW4nCcCHUQAAysQ2-

APPENDIX

Auteur, ou contexte spatial et temporel	Préconisations concernant la circulation
Antiquité, Europe	Trottoirs et passages piétons pour **dissocier** les modes de transport ; Dispositif de **gestion de sens de circulation** différenciés, et de **séparation des flux** par superposition
V. A. Palladio (architecte), 1570	La commodité des voies en lignes droites **soulage** ceux qui marchent et leur procure plaisir et satisfaction
Henri Gautier (ingénieur), fin XVIIe siècle	Dimensionner la largeur des chaussées proportionnellement aux **files** de véhicules
XVIIIe siècle, Europe	Dissiper la **congestion** des flux par une meilleure configuration des voies ; Concevoir des voies larges et droites, ayant la capacité de garantir une **circulation ininterrompue** des personnes et des marchandises
M. A. Laugier (abbé et historien de l'architecture), 1753	Les réseaux dont le plan est répétitif sont sources **d'égarement** pour les individus (on s'y perd)
Pierre Patte (architecte), 1769	Il faut que tous les abords soient **faciles**, qu'il y ait suffisamment de **débouchés** d'un quartier à l'autre pour le transport des marchandises et la **libre circulation** des voitures
J-N-L Durand (architecte), 1794	Les communications doivent être les plus **courtes** et les plus **commodes,** la ligne droite est pour cela la première condition
XIXe siècle, Europe	Il faut plus **d'efficacité** dans les déplacements
Léonce Reynaud (architecte et ingénieur), dès 1836	Les réseaux en grille ne **desservent** correctement la circulation que dans deux directions ; les rues trop brisées rallongent les **distances**
G. E. Haussmann (haut fonctionnaire et homme politique), 1852-1870	Tout doit circuler, il faut **relier** les points importants de la ville, **répartir** le déplacement des piétons et celui des véhicules sur des sites propres (trottoirs et chaussées)
Ildefons Cerdà (urbaniste, homme politique, entre autres), 1859	**Circulation généralisée, accessibilité rapide** aux différents lots découpés par le plan, **déplacements répartis uniformément** sur le réseau en grille, **perméabilité, communicativité**
Etienne Cabet (penseur politique), 1840	Hiérarchisation du réseau viaire, de sorte que chaque type de voie soit destiné à la circulation d'un type de **flux** particulier
XXe siècle, Europe et Amériques du Nord	**Efficacité et sécurité** par la séparation des déplacements piéton et automobiles

Le Corbusier (architecte, urbaniste, entre autres), 1925	La **vitesse** des automobiles ne doit pas être brisée, leur déplacement ne doit pas être **encombré**, il faut garantir le fonctionnement optimal de la « machine circulatoire », assurer une **fluidité** maximale et un **débit** continu. Pour cela, le réseau viaire doit être hiérarchisé, suivant un quadrillage régulier, avec des voies droites et longues, et des croisements tous les 400 mètres ; Les voies autoroutes traverseront en transit et selon le réseau **le plus direct, le plus simplifié**, parfaitement indépendant des édifices ou immeubles pouvant se trouver à proximité
F. L. Wright (architecte), 1934	Réseau de circulation performant, assurant une bonne **accessibilité** de tous les habitants à l'ensemble des services et aménités urbaines (accessibilité généralisée), pas de **mouvement centripète**
C. Stein, H. Wright, M. Sewell Cautley (urbanistes, concepteurs du lotissement Radburn), 1928	Lotissement (Radburn) conçu pour « **l'ère de la voiture** », avec un réseau viaire hiérarchisé, comprenant plusieurs culs-de-sac ; Chemins dédiés aux piétons, pour assurer leur **sécurité**
Jane Jacobs (philosophe de l'architecture), 1961	Réseau dense et perméable pour permettre les **déplacements à pied**
Années 1960 aux Etats-Unis	*Planned Unit Development*, lotissements mixtes (au moins deux fonctions) visant à régler les problèmes de **congestion**, de stationnement, de faible accès aux aménités et aux transports publics à l'intérieur des quartiers ; réseau viaire hiérarchisé, composé de voies courbes et de culs-de-sac. Les culs-de-sac visent à réduire la **vitesse** automobile, et promouvoir la **sécurité**
Années 1960-70 en France	*Grands Ensembles*, implantés sur les franges des infrastructures autoroutières, ce qui leur confère une **bonne accessibilité en automobile**
Nouvel Urbanisme, 1980 aux Etats-Unis	Réhabiliter la **marche à pied** grâce à des réseaux viaires aux voies fortement interconnectées

Tableau 4 Summary of traffic-related recommendations made by the urban theorists and practitioners

Tableau 5 The major attributes of walkability

THE MAJOR ATTRIBUTES OF WALKABILITY-Micro scale		
SAFETY	• **ACTUAL SAFETY** ◦ Street pattern ◦ Traffic calming measures ◦ Lightening ◦ Continuous pavement ◦ Pedestrian enclosure ◦ Separation ◦ Floor quality ◦ Street crossings ◦ Vehicle mix	• **PERCEVIVED SAFETY** ◦ Clear delimitation between public and private space ◦ Building orientation towards street ◦ The presence of common use facilities
ORIENTATION	• **LEGIBLE STREET PATTERN AND COMPONENTS**	• **LANDMARKS** ◦ Differentiation ◦ Detailed building form and junctions ◦ Singularity
	• **CONTINUITY**	• **BUILT FORM AND ITS LOCATION**
	• **ARCHITECTURAL AND ENVIRONMENTAL FEATURES** ◦ Building entrances ◦ Building orientation	
ATTRACTIVENESS	• **SIMILARITY** • **PROXIMITY**	

	Economic	Environment
LAND USE DEVELOPMENT	**Density** *Decrease the need to infrastructure *Decrease trip distance *Increase social interaction *Increase tendency to PT use ***Population density*** the number of residents per unit area, ***Employment density*** the number of employees per area, ***Built form density*** the density of built and residential area per hectare,	**Diversity** -Physical -Social -Economic diversities

Tableau 6 The major attributes of walkability (continued)

THE MAJOR ATTRIBUTES OF WALKABILITY-Macro scale		
TRANSPORTATION SYSTEM	**Social** **A. Accessibility** **B. Equity**	
	Sustainable transportation *Effective and efficient integration of various modes of transportation *More accessible land use patterns	Various social-economic groups of people get equal facilities
	Economic Compact land use patterns increase: 1.accessibilty 2.economic productivity and 3.decrease transportation cost	**Environment** Sustainable transportation modes, 1.save energy 2. less damage the environment 3.reduce dependency to foreign languages
LAND USE DEVELOPMENT	**Density** ***Population density*** the number of residents per unit area, ***Employment density*** the number of employees per area, ***Built form density*** the density of built and residential area per hectare, ***sub-centers***density is known as the density of most dense centers	**Diversity** The diversity of the land use within a given geographic area. (the proximity of distance between destinations)

THE MAJOR ATTRIBUTES OF WALKABILITY-Meso scale			
TRANSPORTATIO N SYSTEM	**Social** **A. Accessibility** **B. Equity**		
	Network connectivity 1.road network 2.street connectivity 3.block size and density		-Horizontal equity -Vertical equity -Vertical equity with regard to mobility need
	Network pattern -Interconnected network patterns (a. ensure alternative trip modes, b. increase trip frequency)	**Separated walking biking system**	

	• COMMON GROUND OR COMMON ENCLOSURE • ORIENTATION • CLOSURE • CONTINUITY
COMFORT	• PHYSICAL USABILITY ○ Protecting pedestrians from climatic conditions ○ Possessing clean air ○ Possessing actual and perceptual safety ○ Being accessible • VISUAL UNDERSTANDING ○ The principle of orientation ○ legibility
DIVERSITY	• PHYSICAL DIVERSITY • SOCIAL DIVERSITY • ECONOMIC DIVERSITY
LOCAL DESTINATION	• DISTANCES BETWEEN ACTIVITIES (HOME TO SHOPS, SCHOOLS, PLAYGROUNDS, ETC) • INTERCONNECTED STREET NETWORK

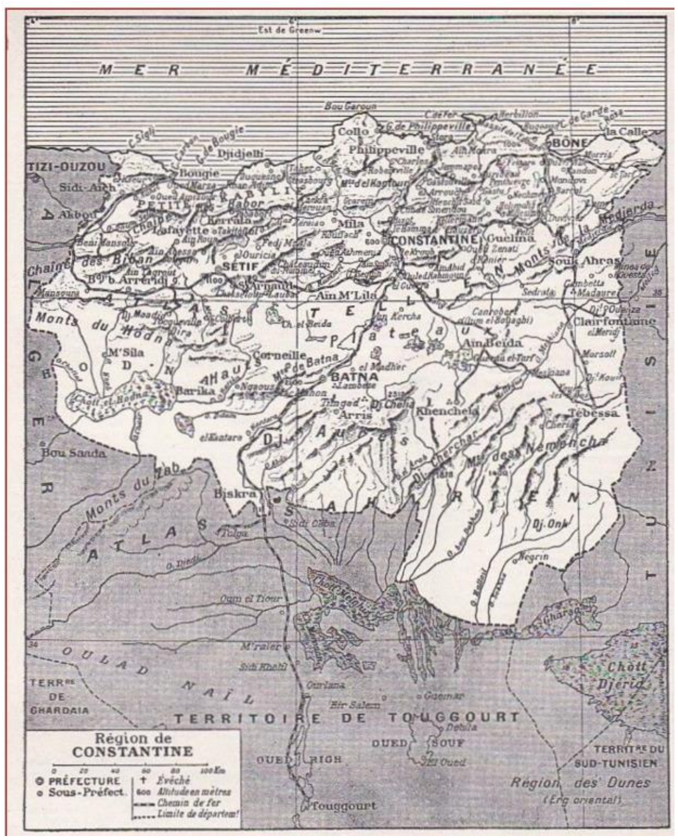


Figure 93 Region of Constantine 1948

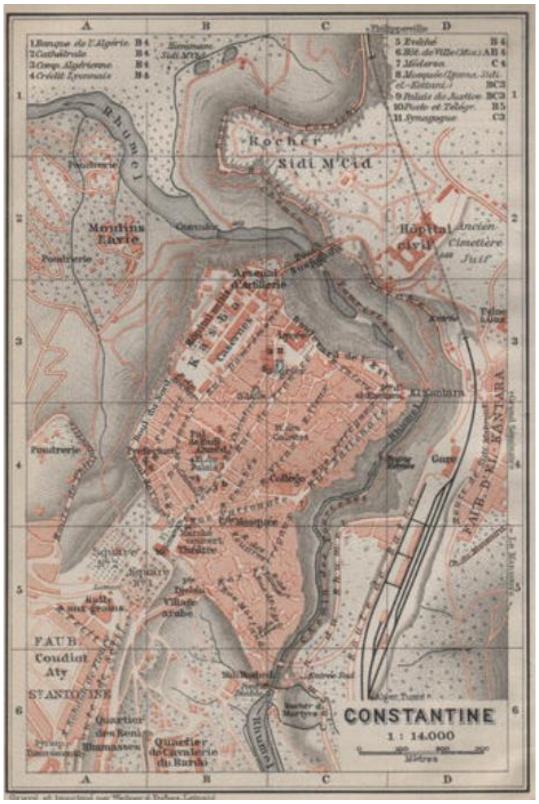


Figure 94 The plan of Constantine after the alignment works

Figure 95 The plan Constantine before the alignment works

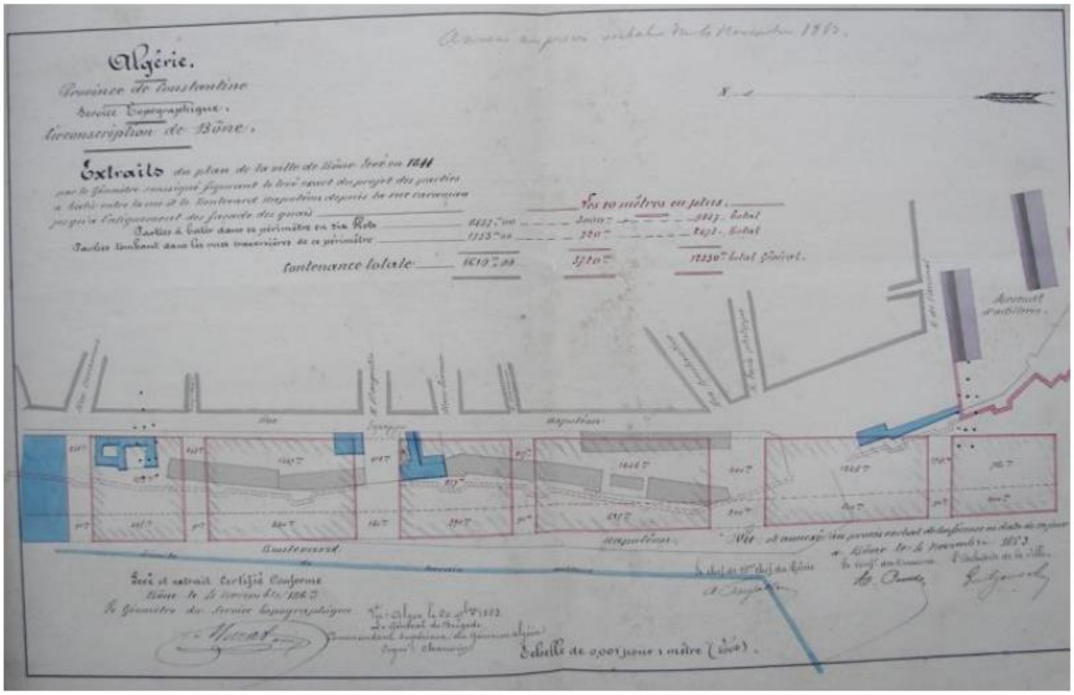


Figure 96 1VH 388; Archives of the "Service historique de l'armée de terre" in Algeria (SHAT); Vincennes

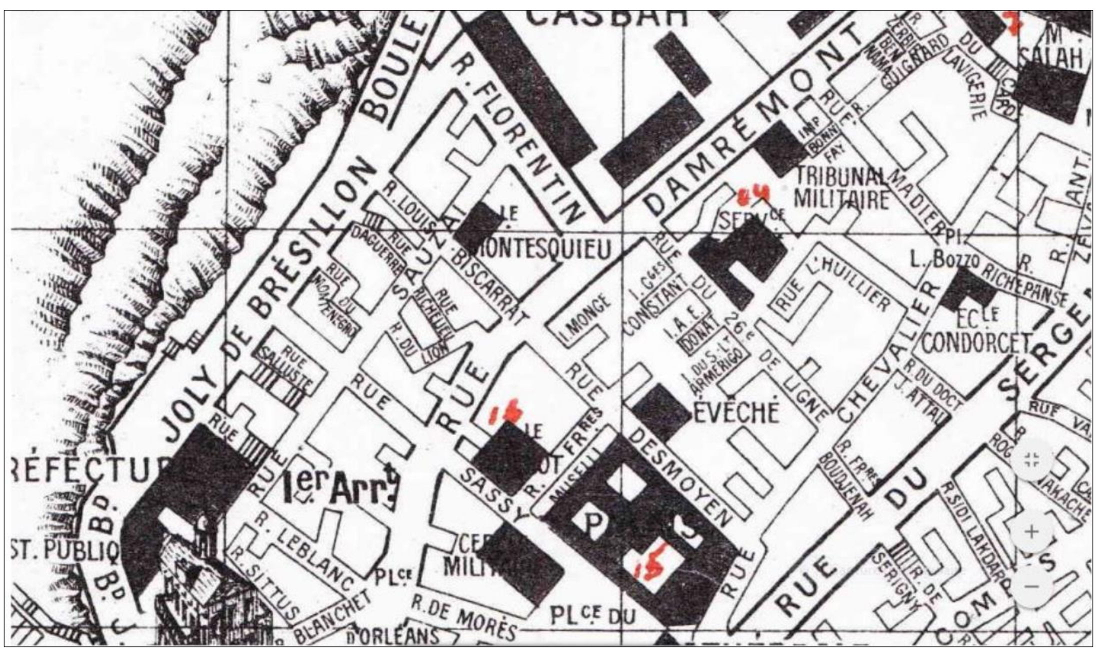


Figure 97 La brèche street of Constantine

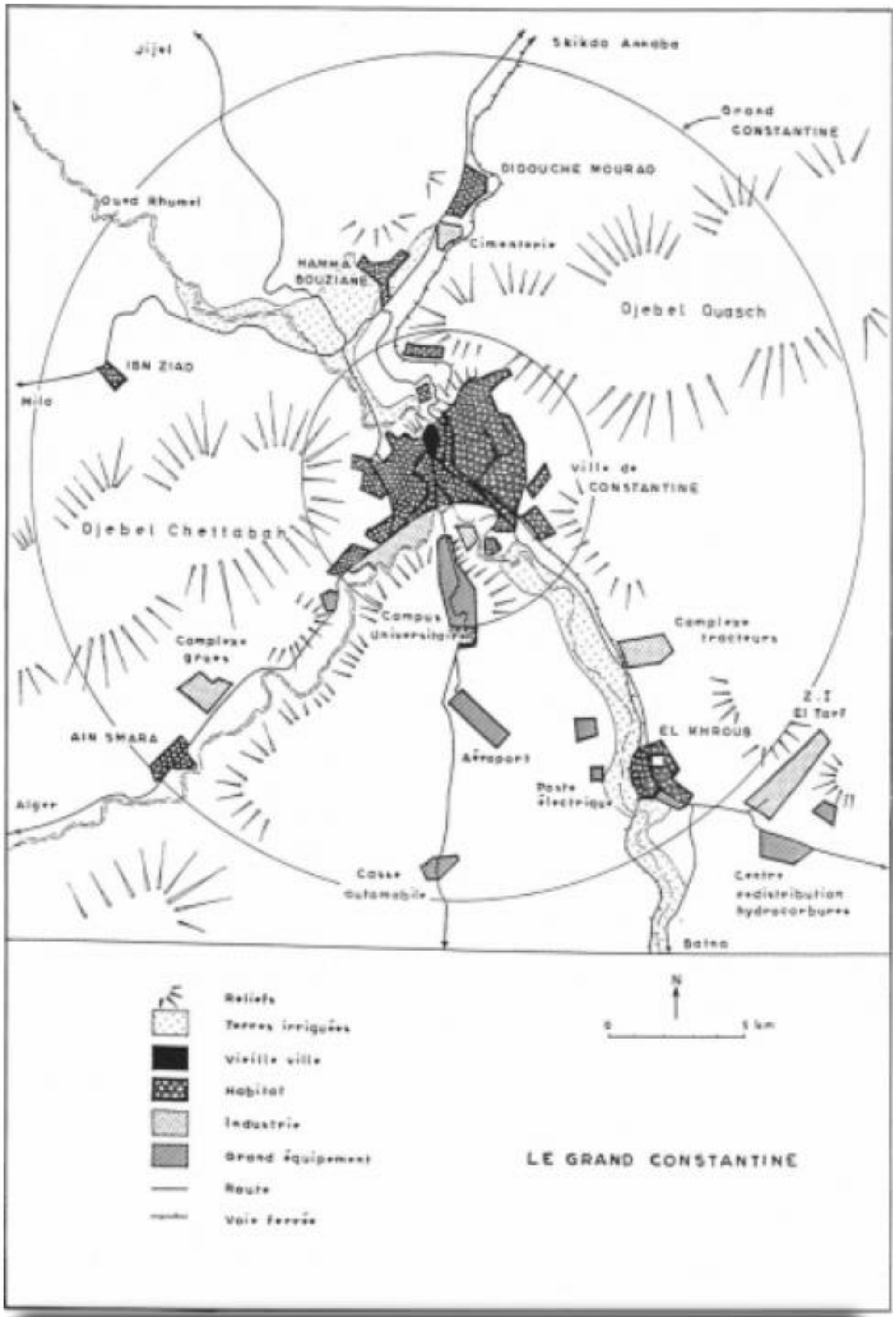


Figure 98 The great Constantine

ABSTRACT

As we experience climate change and a lower quality of life in auto-oriented cities, smart growth and new urbanism are dominating urban paradigms, reshaping urban spatial structures worldwide. Naturally, urban planning, policy, and design aim to create cities that have a low auto-use, high pedestrian-friendly urban form. Walkable communities have several advantages, including reduced automobile journeys, more street activity for local retailers and the community, and better health for inhabitants. Thus, we need to understand the determinants of walking activities to encourage the creation of pedestrian-friendly urban structures.

Many studies have focused on socioeconomic features as the main determinants of walking. These studies specifically suggest that population and employment density, land-use patterns, and land-use mix determine the pedestrian volume in cities. Within a specific area. However, few studies focused on street conditions and connectivity to generate walking alternatives. Early studies of street effects focused on the influence of topological and physical settings on walking choices. However, most pedestrian movement volume models were constructed for urban areas that developed on the basis of pre-modern planning. In this thesis, we confront neighborhoods that were built upon modern planning doctrines, combining the functional hierarchy of streets with the neighborhood unit concept, with neighborhoods that developed from traditional organic streets based on self-organized planning. We employ space syntax analysis to study how the structural elements of their roadway network interact with pedestrian movement distribution. The research was carried out in two physically and historically distinct cities in Constantine, Algeria, namely the ancient and modern towns. These disparities are attributed to the lack of a self-organized circular causation between street network construction, business, and movement in modern planned districts. This research builds on the premise that structural aspects of the physical environment, in addition to functional factors, also need to be considered as offering a significant, even over-riding, influence on walking behavior, reducing automobile dependence and inducing non-auto commuting. The topic connects to the current walkability issue and introduces the concept that the arrangement of the urban grid might impact the proportion of pedestrians. In conclusion, this study confirmed the effects of access to the built volume of various land uses along street networks on walking activities. If the results are firmly tested and generalized, they could be applied to create more effective urban designs. Further, by including the considered preferences of pedestrians, the key findings could contribute to shifting auto-oriented urban structures mainly in the new towns toward pedestrian-friendly urban settings by learning from the urban layouts of the traditional cities. In terms of future research directions, further studies could examine how reinforcing pro-pedestrian policy relieves urban issues, such as traffic congestion, energy overuse, and climate change.

RESUME

Face au changement climatique et à la baisse de la qualité de vie dans les villes axées sur l'automobile, la croissance intelligente et le nouvel urbanisme dominent les paradigmes urbains et remodèlent les structures spatiales urbaines dans le monde entier. Naturellement, la planification, la politique et la conception urbaines visent à créer des villes qui ont une faible utilisation de l'automobile et une forme urbaine très conviviale pour les piétons. Les villes piétonnes présentent certains avantages, tels que la réduction du nombre de déplacements en voiture, l'augmentation de l'activité dans les rues pour les commerces locaux et la communauté, et une bonne santé pour les citoyens. Nous devons donc comprendre les déterminants des activités de marche afin d'encourager la création de structures urbaines favorables aux piétons.

De nombreuses études se sont concentrées sur les caractéristiques socio-économiques comme principaux déterminants de la marche. Ces études suggèrent notamment que la densité de la population et de l'emploi, les modes d'occupation des sols et la mixité de l'occupation des sols déterminent le volume de piétons dans les villes. à l'intérieur d'une zone spécifique. Cependant, peu d'études se sont concentrées sur l'état et la connectivité des rues pour générer des alternatives de marche. Les premières études sur les effets des rues se sont concentrées sur l'influence des paramètres topologiques et physiques sur les choix de la marche. Cependant, la plupart des modèles de volume de mouvement des piétons ont été construits pour des zones urbaines qui se sont développées sur la base d'une planification pré-moderne. Dans cette thèse, nous confrontons des quartiers qui ont été construits sur la base de doctrines de planification modernes, combinant la hiérarchie fonctionnelle des rues avec le concept d'unité de voisinage, avec des quartiers qui se sont développés à partir de rues organiques traditionnelles basées sur une planification auto-organisée. Nous utilisons l'analyse syntaxique de l'espace pour étudier comment les attributs structurels de leur réseau de rues interagissent avec la distribution des mouvements piétonniers. L'enquête a été menée dans deux villes spatialement et historiquement contrastées de Constantine, en Algérie, à savoir la vieille et la nouvelle ville. La discussion fait le lien avec le débat actuel sur la marchabilité et introduit l'idée que la configuration de la grille urbaine peut influencer la proportion de piétons. En conclusion, cette étude a confirmé les effets de l'accès au volume construit de diverses utilisations du sol le long des réseaux de rues sur les activités de marche. Si les résultats sont solidement testés et généralisés, ils pourraient être appliqués pour créer des conceptions urbaines plus efficaces. En outre, en tenant compte des préférences des piétons, les principales conclusions pourraient contribuer à faire évoluer les structures urbaines axées sur l'automobile, principalement dans les villes nouvelles, vers des environnements urbains favorables aux piétons, en tirant les leçons des aménagements urbains des villes traditionnelles. En termes d'orientations de recherche futures, d'autres études pourraient examiner comment le renforcement de la politique en faveur des piétons soulage les problèmes urbains, tels que la congestion du trafic, la surconsommation d'énergie et le changement climatique.