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MANAGING URBAN TRANSITION

Place-sensitive approach towards technological resilience

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An Iranian researcher who is passionate about the workings of the world. An Iranian Kurd born in the western mountains who is eager to learn more about the philosophy of life, biology, mathematics, and human sciences. As a member of IMO with limited complexity knowledge, I look forward to a brighter future as multidisciplinary scholars take on this subject.

Poya Sohrabi

MANAGING URBAN TRANSITION

Place-sensitive approach towards technological resilience

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Abstract

The thesis attempts to explore the complex nature of urban context in the transition phase to discover the system's hidden perspectives under the resiliency lens. Research launches the process by an introduction from the TREnD project to the ongoing issue of disparity in European regions and cities. Introduce a mixed-method strategy in creating a conceptual framework for picturing a complex system (Urban area) emerging new state during manifold progress of the transition and utilizing this framework, an endogenous characteristic of the process introduced as the ongoing process of learning by doing namely resilience. To assess the theoretical model, quantitative methods are applied, Big-Data analysis paves the way to illustrate the network of interconnectedness between cities and innovation drivers, and descriptive models could interpret the nature of this process. Borrowing theories from biology, mathematics, and complex theories, the research emphasizes a long-term run for a structural change instead of a one-sized method to identify a city's evolutionary path. In this context, the special attention to technology is a unique approach to quantifying theories on the measurable ground during this effort. This research applied suggested models in two case studies, Calabria as a European region with a long history of structural issues and Boston in the USA as one of the well-known innovative areas of the American continent. TREnD project, as the principal rationale of the project, shed light on the various concept in both theoretical and practical domains, and this particular research attention is on a place-based method for measuring technological resilience to give the opportunity to the policymakers, communities, and scientific fellows to deal with this complex issue. A Series of the algorithm, network mapping, distance heatmaps, and conceptual frameworks will introduce during this attempt.

Introduction of research project

The urgency to adopt game-changer regional policies is an issue perceived by wealthy and lagging regions. A stark spatial development unevenness throughout the EU regions, which has been widening, has put the efficiency of the current EU Cohesion Policy under question. There is considerable variation in Gross Domestic Product (GDP) per capita (in terms of purchasing power standard) in the EU and within its member states. It has been documented that the smart specialization strategy has failed to explain precisely how it can provide a common political rationale to a socioeconomically and geographically diverse set of regions and nations facing different place-based challenges and innovation modes. Hence, quite legitimately, different general policy agendas—reforming Cohesion Policy as soon as possible appears to be an urgent matter for the post-2020 regional policy programming to create new industrial paths for first-tier and lagging regions, as well as a shift from structural-change-oriented programming. The answer lies in bridging resilience, as an ongoing process of change rather than a temporary return to an equilibrium state (pre-existing or new), with diversification as an effective tool to absorb shocks. In the region with weak levels of connectedness, entrepreneurial spirit, industrial diversity, quality of local governance, and a critical mass of capabilities to develop collective learning processes, the Smart Specialization agenda fails to provide an appropriate answer (Bevilacqua, C. 2017 TREnD project). From the initial evaluations of RIS3 plans, it is evident that there is a systematic lack of capacity to identify new related activities, which hinders the diversification of technological domains around local historical specialization patterns. The objective of the EU Cohesion Policy is to adopt a change-oriented methodology through a Revised Regional Innovation. However, the policy has been nuanced by continuous shocks and crises. It is difficult for regional authorities to improve the quality of existing specialization through a creative and appropriate diversification process. Due to the lack of absorptive capacity and creativity of local small and medium-sized businesses (SMEs), the local scientific community can only participate in formulating regional strategies.

On the other hand, frontrunner regions may find it challenging to target the EDP, which is a plausible argument effectively. Choosing priorities can be highly challenging in regions endowed with an extensive range of specializations. Pushing the reforming process of the Cohesion Policy forward, therefore, proves to be an urgency for the post-2020 regional policy programming to create new reliable industrial paths that represent a crucial challenge for both first-tier and lagging regions and shift from structural-change oriented programming methodology to one with an evolutionary perspective. Development policies through the innovation boost. In light of current debates on regional diversification as well as the emerging role of cities in fostering a local innovation ecosystem, the objective is to explore new development policy configurations that drive the response of different territories to continuous shocks within an evolutionary framework (Bevilacqua C., 2017TREnD project). It is pertinent to bridge resilience, as ongoing change rather than recovery to a pre-existing or new equilibrium state, with diversification, a means of enhancing regional resilience to absorb shocks, and Evolutionary Theory based on "continuous and progressive change Diversified or place-based development strategies are required, especially at the local level, to encourage adaptation to the specific stocks of regional economies arising from globalization and market integration. (Bevilacqua C., 2017 TREnD project). There are two primary objectives: 1) to adjust the current evolutionary perspective for more integrated spatial planning capable of coordinating the regional and local levels for the implementation of place-based development policies, and 2) to introduce an evolutionary perspective to the post-2020 EU Cohesion Policy by constructing an improved approach to the design of regional innovation policies that incorporates transition management (planning) and resilience building (governance) Regional economic resilience has been heralded as "the ability of a system to adapt, re-organize itself and change its path of growth" (Bevilacqua C., 2017 TREnD project). Despite a growing interest in regional economic resilience and its relevance in explaining "the capacity of a region to develop a new growth path" (Boschma, 2015), the concept deserves to be better defined concerning a time framework regarding the resilience processes. For territorial contexts to be resilient, a legacy from the past, place-based metrics, and impact measurements are critical. Analyzing these opportunities reveals the untapped potential for reshaping trajectories. These potentials are manifested through the windows of local opportunities due to external shocks to which regions are constantly exposed. (Bevilacqua C., 2017 TREnD project).The purpose is to relate the theoretical approach originating from the evolutionary economy topic with the necessity of providing a practical explanation of resilience and transition in terms of indicators and metrics of the Cohesion Policy from an evolutionary perspective. In so doing, it will help unveil the impact of the territorial aspects regarding resilience-building processes towards new equilibria, namely, new territorial development patterns and trajectories. Much emphasis is to be put on governance aspects regarding the resilience-building process, including local networks, transition arenas, and the role of external actors. In the meantime, spatial analyses should be used to assess the impact of place on the diversification process. Hence, to prevent an increase in regional disparities in the post2020 European Cohesion Policy, policy packages must be better integrated, coordinated, and delivered at national, regional, and local levels. So, a more potent multilevel governance model conducive to a more reactive and responsive public administration is primarily required in a knowledge-based society. Therefore, public involvement is critical to increasing the impact of R&I outputs, enabling the conversion of knowledge and ideas into products and services. The evolutionary approach to discovering "novelty " is proposed through a strategic effort to challenge the current regime to disclose "niche markets. " A closer examination of the forces and agents at work in creating different forms of adaptation at the urban scale is supposed to reinforce the regional diversification toward an evolutionary dimension of the Cohesion Policy. Since the research project is influenced by the TREnD project, which is a multi-disciplinary project among an international group of people in the European union and the united states, the findings of this thesis are a small step forward in the project's general goals. Moreover, this project evaluates a triggering action related to transition management by strengthening the resilience-building process. According to this idea, three research projects in Italy (Calabria) and the USA (Boston) will be discussed. Based on the research aims to conceptualize urban-level connections under the complexity theory, first adjusting the current evolutionary perspective for more integrated spatial planning and coordination at both the regional and local levels is suggested. Investigating an evolutionary perspective on the post-2020 EU Cohesion Policy by constructing an improved approach to place-based development plans that incorporates transition management and resilience-building is the second step for contextualizing urban resilience called place sensitive approach. It has been tried to introduce a complex urban system in which shock causes a change that leads to evolution. This evolution can work in both ways, either enhancing or not. The process which can cause improvement in the system performance is called resilience building. Economic investigation of the urban area and using the definition of shock as a concept starting the evolutionary process is the main foundation of urban economics resilience. This definition and the variety of its debate will be discussed in detail in chapter one. Information plays a significant role in revealing the complexity of the urban system; thus, it can be assumed that big data for urban management has become a fashionable method both in developed and developing countries. In this research, the author tries to analyze different data sets and methods in the United States and the European Union. The thesis also aims to assess the reason for the relationship between shock, transition, evolutionary development, and resilience building.

Methodology

The methodology of this thesis is based on an empirical method. Through the application of ideas and the exploration of literature, the thesis explored the idea of learning. The theoretical portion of the thesis consists mainly of a literature review of the essays, which thoroughly analyze how economics has evolved in urban areas. An additional tool was used by the researcher to gather information to analyze the different scholars' essays on evolutionary economic development, called the literature review form, presented by the Trend projects. Consequently, the researcher turned to related case studies to analyze the atmosphere of the research field before launching the thesis and where to find their data. The researcher used the data from public databases and private institutes in Italy and Boston to find relevant case studies. Using economic clusters in urban areas has been demonstrated in the series of projects in Boston, and porter cluster mapping is one example. The purpose of this thesis is to elaborate on different types of models for reliable data to be used in European countries.
A theoretical framework to help construct, expand and justify the project's theoretical framework. A methodological approach that links evolutionary and transition theories with mathematical models and statistics is used to define actions that capture the complexity of resiliency issues in the context of a localized and unique identity. We devise algorithms, define coefficients,

and highlight indicators using data-driven strategies in this research. It has been shown that the methods can be tested on a case study in the EU (Calabria) and in the USA (Boston). After every chapter, the understanding of each step will be explained, as well as the need for a more holistic picture of how to manage the urban transition in the next chapter. As stated earlier, it is essential to highlight that the objective of this study is to exhibit interdisciplinary approaches by taking a quantitative approach to a qualitative concept of connectedness. Several theoretical bases can be applied to deal with shocks at the urban level, including Complexity theory, Network theory, Information theory, and Endosymbiotic theory. The purpose of the research is to perform a mixed-method analysis of public data sets to identify trends and behaviors and apply regressions to create a model that will enhance the statistical foundation of the research. The purpose of this study is to review theoretical approaches to transition phenomena from a qualitative perspective. This paper explains how evolutionary theories offer a back door into complex studies of resilience and how understanding resilience measurement in this context opens up a new vista of possibilities. We hope to demonstrate how resilience is rooted in the transition process, which can either stimulate or depress it based on its pace and quality.

Result

This thesis is based on exploratory research. As described in the methodology section of this short introduction, as the complexity of samples and hypothesis required, the quantitative aspect of research gives room to rely on a mixed-method research strategy to respond to the qualitative nature of the study in a descriptive way. The first chapter's findings explain the complex status quo of the current disparity in the research context (EU and USA). Introducing urban complexity to picture a theoretical framework for "transition with resilience." The first chapter's findings will demonstrate the relationship between illustrating a complex issue and a heterogeneous property of its own. This way tries to explain managing urban transition under the lens of urban resiliency, together with the evolutionary economy and the call for transition. After theoretical exploration of these concepts, next will introduce a tool to encounter this interconnectedness. This article is a

conclusion to all the research done in the first year of the Ph.D., which was mainly focused on literature review and was achieved by reading different data on the European Union, Boston municipality, plans on how to assess resilience, sustainability of a city and what evolutionary economy is. The second chapter primarily focuses on Network theory, Networking analysis, and the Endosymbiotic theory of economic clusters living inside a network of cities. In this chapter, we discussed the descriptive results of the Social Networking Analysis of the Calabria region and Hamming distance application in a panel data analysis of the same southern Italian area to elaborate the toolbox of the Place-Based resilience strategy. Findings such as four layers of networks generated from an Italian public dataset and the DNA-shape schemes of each territory based on the economic sectors tend to locate in the area disclose a new perspective on urban complexity. To give the chapter scientific context, an article that is the result of the first season of the second year of the writer's Ph.D., written for the TREnD project and published in the journal. Its main goal was to show how method and network analysis can capture innovation flow on the regional scale and how to show it on the local scale. The final chapter focuses on Technological resilience and measures it utilizing big-data analysis. The explorative methodology is the same pattern for this chapter investigating Boston metropolitan area. This high-tech American urban context can reveal the preparedness and disparity close enough to measure. This chapter finding involved a twofold report; first, we emphasize a neighborhood level to determine how the case study responds to the pandemic shock and if this has special attention on tech-related projects.
The result of this report leads to the next fold of the research on clustering the neighborhoods based on the characteristics extracted in the first linear regression model utilizing the K-Means clustering method. This fold of research tries to answer the question of innovation footprint on the behavior of the neighborhood in a longitudinal panel data that merged all real-time community non-emergency results (311 datasets) with building permits requested for different areas of Boston during ten years. For this chapter, there were two articles presented. The first showed how the pandemic shock affected the city of Boston and how we could assess it using the network method. It was achieved with the help of researchers from other parts of the project, namely the Aristotle University of Thessaloniki. The last essay is a conclusion based on all three years of research. In its network, theoretical research on resilience theory and evolutionary theory. We were also able to show the process of community contribution and its effects and urban planning and the connection between different neighborhoods in a city. The result will show us how innovative neighborhoods of this case study behave differently facing chronic shock during the research period, specifically during the Pandemic 2020-2022. After this three-chapter, the thesis will discuss the general finding of 3 years of research on managing the

urban transition in a report to explain three main principles: The urban context complexity can neither be reduced to a linear causal relationship nor dealt with from a monodisciplinary perspective. Understanding the system should follow complexity theory and consider the evolution and emergence of unexpected newborn results for the exact formula applied. However, resilience has a variety of definitions, and there is no one-size-only method to measure it. Still, a long-term, episodic algorithm can calculate the proxies of this concept at the city level. Resilience is a property of the transition that stems from this evolution that could stimulate or halt as an Endogenous nature. Big Data is crucial in managing the urban transition; real-time participatory and georeferenced data could lead policymakers to compare and evaluate the risk. Creating network-based models on real-time urban data encourages citizens to participate in the evolution of the place, thus diversifying the opportunities to respond, recover and reinforce the structure. The thesis and four articles were in the sequence of theoretical courses, using the tool suggested in Italy, later in the United States, and finally, using all of the theory on a community-level scale.

Conclusion

There is a problem in that there is an imbalance between the regions of the European Union, which in turn leads to a gap. There have been several attempts to resolve this issue over the last decades, but none have succeeded. We believe the reason is that there has not been a suitable tool and scale for that. Introducing and exploring tools to help policymakers move from a carbon-based economy to a post-carbon economy is our first step. Our focus is on the fact that resilience has been described in many different ways. However, none of them adequately address its main feature, which is the interrelatedness of its components. The thesis includes three chapters. First, it introduces the theories behind transition and evolutionary economy, particularly the relationship between this phase of transition and complexity, complex theory, and the levels of understanding of this theory in urban studies. Then we go more in detail to show one practical model to conceptualize the urban/local transformation in a complex puzzle of interconnectedness to show the potential of this tool. Finally, for the last part of the first chapter, the research paper published in August 2020 in the Italian urban regeneration journal will explain the theories. Second chapter will go more into detail on applying Network principles to urban transition; in this chapter, we explore the network attributes and their interpretation of local identity, distances, and proximity. By taking a comprehensive view of complex systems, interactions, and synergies, the research reveals two biological theories that have been incorporated into urban studies. First, using social network analysis, these assumptions are interconnected. The endosymbiotic theory explains the existence of mitochondria inside each cell of eukaryotes and hamming distance, which helps us understand the difference between two strands of identity (DNAs). As a reflection of these concepts, we try to illustrate how the economic sector's networks within a region can give life to a local unit like a cell to generate wealth and encourage the system to grow and emerge into a new phase during and after each state of the transition. We borrow cluster-based analysis (introduced by porter) to create a network and find an identity for a local unit, first to localize this unit among the rest of the system and second to distingue their unique economic sector contribution to an emerging path of them. As mentioned earlier, global scale programs (Such as the EU program for European regions) are a trade-off between concentration and diversification. In looking at local units within a region, the zoom in/out process is also stimulated to diversify community actors within the region and to focus more on those that have tremendous potential. In order to do this, the most precise pinpointing is as necessary as imagining a comprehensive network of interactions in order to achieve the highest level of effectiveness. The third chapter explores resiliency, looking at this concept under the lens of complexity, introducing various definitions for resiliency level and technological resilience as the particular concept of this research project. This chapter applies a quantitative approach to the city's technological resilience assessment benefiting from Big-Data algorithms. Dealing with the place-based resilience model allows modeling a city based on the neighborhood's investment level in Technology and comparing this rate during acute shocks such as pandemics to understand the identity of response. Then we conduct a Hypothesis on technological resilience to find out if a particular innovative level in some neighborhoods could affect the whole urban system to respond against acute shocks? Having this, Is the so-called diversification/ concentration bargain leading to the Technological resilience of a city in an inclusive end? This chapter ends with a research paper testing them in a Boston case study to answer these questions.

Chapter 1

Transition with Resilience in Urban context

Abstract

Human becomes part of an urban system when they are involved in the setting. In this chapter, we will review the process of transformation, and we will give a detailed explanation of the evolution and evolution process that are the next steps on our journey. It is necessary for resilience to live in a high-turbulence era such as that of 2022; thus, the second sub-chapter explains resilience in different domains of our lives. As soon as we contextualized the concept into the urban setting and merged it with a transition strategy for a place-based approach, we became aware of a new frontier called "place-based resilience.". In order to elaborate the concept into a practical action plan, we present our understanding of the area at a management level, referred to as managing the urban transition in order to develop a practical action plan. A framework and definition of the study topic are provided in this chapter as the first step toward exploring the concepts of the thesis title. A research paper summarizing the results of this work titled "Networking analysis in the urban context: A novel instrument for managing the urban transition" elaborated on the chapter's result.

Introduction of chapter 1

1. Introduction

It is important to note that the purpose of this chapter is to describe the thesis keywords, the scientific approach, and the form of the nexus mentioned factor. Using non-native concepts, including technological resilience and social network analysis, the study seeks to connect transition and complex system studies in urban areas. It aims to provide a way for a human to transform a complex urban space into a powerful engine that can trigger the whole system during transition based on cognitive maps. The conceptualization framework of this thesis is recalling scientific abrokwhich is only one piece of a giant puzzle of the global economy, society, and environment. The author will introduce and form the potentials that can emerge from this approach. This chapter will discuss how evolutionary theories can connect the relationship between resilient cities, stable economies, and stable environments. As a result of this chapter, the writer convinced also like to conclude that transition depends on resilience, and stability is an integral part of both resilience and stability. Due to the fact that resilience and transition cannot be viewed as separate concepts, it follows that evolution cannot take place if the transition occurs without resilience and is not stale, as the result is a failure of the process. The purpose of this chapter is to examine how these concepts are related to the conceptual framework. Furthermore, we present a paper related to this section, which introduces a tool for drawing patterns on networks using Big data, which leads to the primary tool we will focus on in this chapter.

2. Transition theory

As described by (Chick & Meleis, 1986, p. 238), the transition is a process that occurs over time and can be divided into stages and phases (Chick & Meleis, 1986, p. 236). It is defined as a "transition between relatively stable states" (Chick & Meleis, 1986, p. 238). Various researchers have presented transition as a central concept in transformation for the last four decades (Li & Hu, 2018, p. 16). The components of transition have been identified and described (Chick & Meleis, 1986, p. 35), expanded to include one additional typology (Li & Hu, 2018, p. 20), and the concept has been extended and redefined (Meleis et al., 2000, p. 8). Transition theory describes the process of transforming a phase to several other phases or even just another phase. The critical aspect here is to know the zero phase, the pathway, and draw the first phase, which is the destination of that phase. The transition process usually starts from one or several triggers, passes through a resilience process, and after going through several stages, arrives at its destination. If we consider the transition a linear process, it leads us to a mistake in understanding the definition of transition to the definition of conversion. Conversion is not an irreversible identity process since transition processes like conversion and adaptation transformation, so by getting to phase 1, we will not have items to do before the transition process. Also, it is not irreparable(Sun et al., 2017, p. 6); it means that in the transition process when we get material from zero point to point 1, in point one, we cannot understand the mistakes by knowing the aspects of point zero thus no return to materials and assets of point one .it can be seen to what extend one has achieved one's goals. For example, if one wants to change material to a product. All the maps and blueprints show the person how to get it to the final product; after that, the amount of his achievement to the standards is measurable and finally, getting the product to its best version is possible in a way that during the process of turning the material to the final product it does not have the best outcome. However, the duration of the process causes better productivity for the product. This issue about transition has some key points; first of all, the blueprints are not pre-made (Trani et al., 2015, p. 3); also, the goals are not measurable (Kemp & Rotmans, 2004, p. 8) with the linear process and multidimensional drawings; secondly, the raw materials are not unified and are not static; also, the final product is dynamic. For example, when one wants to study society, a person, or a growth process, take into a transition, one cannot have a blueprint of the product, and one cannot put down all the ingredients; therefore, the transition is an unpredictable process, but it is controllable with the standards available and based on the processes needed. That is why to start to know transition theory; we need to separate the issues into simple questions, challenging questions, and complex questions.

Simple questions can be solved using logical and easy solutions like baking a cake that has a recipe, clear ingredients, and the methods of baking and a measurable product. For difficult questions, although we can know their solutions, the algorithm for solving those questions is the process of solving those questions. We know how a man goes to the moon. However, a selection of controllable components that we can put all in an optimum level for sending a man to the moon is mercenarily not in the hands of all people or even all nations, so sending a man to the moon is predictable, assessable, programable and understandable but achieving it is not as easy as achieving simple question components. complex questions are, in a way, kind of questions; we know the ingredients, and we know our expectations of the process and the final product. However, their variables are so wide and diverse that we cannot say by solving a few of them, we can say the rest can be done this way; a simple example is bringing up children, although the children grow up in the same family with the same rules, the second child is bringing up with the condition of them both being the same (relatively same since the environmental factors definitely change unless for a twine) can be different. Moreover, their behavior in their maturity will also be different, so there is enough knowledge and understanding to bring up the second child, but the process changes so much that we cannot say the methods will be the same and those two children will behave the same. There is enough understanding for bringing up a child, but the amount of transition a person has from one step to another is a way that we can get to the same result after transition, so the main part in understanding transition theory is that we should reject some default notions. The first notion is knowing the ingredients completely or, better say, zero phases. We should not have any default notions in the zero phase since there were systems like human systems, biological systems, and psycho systems that people wrongly understood. they could further their knowledge only after scientific transition; even at the time of writing this paper, there does not exist a definite answer for knowing ethical, biological, environmental, or even religious foundations. So, all the transitions from the zero phase that is not understandable are not controllable. So, having a default notion of having a complete understanding and then starting an action is rejected. The second notion we reject is the claim of complete control over transition. The transition has never been a controllable process. Transition is a multi-dimension process. Although one can draw it as a linear process connecting phase zero to phase 1, the thickness, depth, and amount of turbulence are all dependent on the behavior at the moment between zero to 1. Relative theories in physics somehow explain transition theories (Becker & Karplus, 1997, p. 5). Systems in their mid-phase have qualities that differ from their previous mid-phase, which is a stepping-stone to the next phase. To better clarify, the path from phase zero to 1 can be divided into thousands of parallel sub-paths in a way that each of these sub-paths can have a different dimension focusing on each other in such a way that a change in the trigger of transition can vary the outcome from most probable method to get to our goal to the farthest result. In the case of bringing up a child, for example, we can say that Each day and hour of bringing up a child is based on the environmental items; the moments of growing up and changing into a new human can bring the person quite close to our goals or quite far from our goals, so the transition has several layers and sub-phases (Li & Hu, 2018, p. 3)which analyze complete control over these sub-phases is impossible. In Schlossberg's definition(Barclay, 2017, p. 24), a transition refers to any change in relationships, routines, assumptions, or roles that results from an event or non-event. Events, or non-events, cannot be defined as transitions unless they are defined by the individual experiencing them. During transitions, perception plays an important role(*Schlossberg. Pdf*, 2018, p. 11). To understand a transition's impact on a particular individual, we must consider its type, context, and impact. It is possible to classify transitions into several different categories. There is one transition in life that is predictable, and that is college graduation. It is not uncommon for unexpected transitions to occur, such as divorce or losing a loved one. The term "non-event" refers to a transition that is expected to occur but does not happen as expected. A non-event, for example, is the fact that someone was not admitted to medical school. There is a relationship between personal non-events and personal goals. Whether it is a delayed non-event, which is an anticipatory event that will still happen, or a resultant non-event that is caused by the event. it refers to the relationship one has with the transition, the setting in which it takes place, and how the transition takes place. A transition's impact is determined by the degree to which it alters individual daily routine. Schlossberg identified four major sets of factors that influence a person's ability to cope with a transition: situation, self, support, and strategies, also known as the 4 S's(Barclay, 2017, p. 25). So, controlling all the transition processes is impossible in one collection, so by rejecting complete understanding and control in the third default notion, we can say the result is a new product based on all the sub-theories in this text. The final product is still complex, dynamic, not controllable, and not completely understood. So, since we do not have a comprehendible understanding from the before (phase 0) transition, the moment something is created, it enters the transition process, and the transition process is so complex with menu sub-phases that we cannot control it. Thus, the resulting product cannot be put into a linear product, which means we cannot put a complex system after transforming in transitional process into a category as a weak or strong, a system has many aspects which can develop, but for measuring each of these aspects, we need a complex process which can show the effects of other aspects on the aspect we focus. Also, the system is in the process of transition since the last moment of life. Having all said regarding the transition, We strongly stress that we do not want to present a method for understanding the economic environment or urban networks completely. it is known that this understanding is incomplete, but we are stating that we want to make a tool available for researchers and policymakers so that they can get and understand the interconnectivity of cause and effect as much as possible. However, we have no tool for foreseeing the future or complete assessment of transition; we have a complete declamatory view that what we do is we could make a definite tool for understanding transition.

2.1.1. Economic transition

Economists study the behavior and interactions of economic agents and how economies work. Microeconomics studies essential elements in the economy, including agents, markets, and their interactions (Åslund, 2019, p. 26). A household, a firm, a buyer, or a seller may be an individual agent. As a system where production, consumption, saving, and investment interact, macroeconomics analyzes the economy as well as factors affecting it: employment of labor, capital, and land resources, currency inflation, economic growth, and public policies that affect these factors. Transformations aimed at converting a centrally planned economy to a market economy result in market-oriented institutions in transition economies. It is important to note that economic liberalization is one of these factors, where prices are determined by the market rather than by central planners. It is not only the removal of trade barriers that is being promoted, but it is also being pushed for the privatization of state-owned businesses and resources, the restructuring of state and collective enterprises as businesses, and the creation of a financial sector to facilitate macroeconomic stabilization and private capital movement. Detailed studies have been conducted by China, the former Soviet Union, Eastern bloc countries of Europe, and some third world nations on the economic and social effects of the process in China, the Soviet Union, and Eastern bloc countries of Europe As a result of a transition, institutions, especially private firms, are usually altered or created; the state's role changes, resulting in fundamentally different governmental institutions and the development of independent financial institutions, companies, and markets. State involvement as a growth provider is being replaced by state involvement as an enabler, while private sector participation is being replaced by private sector activity as the engine of growth. One method of transforming the economy is to change how it grows and how it practices. Transitions can be micro or macro, partial or whole. True transition economics should include micro- and macro-transitions. Depending on the initial conditions of a country, different transition models are used to convert from planned to market economies. As well as the transition from capitalism to socialism, the "transition period" is used to describe the period before the establishment of fully developed socialism. Implementation of private property rights is an essential indicator of transition in a market economy, as they characterize a market economy. ("Transition Economy," 2022, p. 52)

During the transition process, the following factors are essential:

Liberalization, Macroeconomic stabilization, The restructuring and Legal and institutional reforms.

The International Monetary Fund's Oleh Havrylyshyn and Thomas Wolf define transition in broad terms (Castello-Branco, 2001, p. 3):

-Liberalizing economic activity, prices, and market operations, as well as reallocating resources for maximum efficiency;

-Developing market-oriented indirect instruments for macroeconomic stabilization;

-Achieving economic efficiency and effective enterprise management through privatization;

-Implementing hard budget constraints to provide incentives for improving efficiency; and

-Creating a framework for protecting property rights, ensuring the rule of law, and creating transparent market-entry regulations.

To reduce the social and political costs associated with transition adjustments, Edgar Feige encourages privatization methods (Feige, 2017) that are egalitarian as well as recognizing the trade-off between efficiency and equity. It would cushion disruptions caused by transitions by providing social safety nets. EBRD developed a set of indicators to assess the progress of the transition. A classification system was created in the 1994 Transition Report by the EBRD , but has since been revised and amended in subsequent reports. Indicators of transition used by the EBRD

They include:

- Large-scale privatization
- Small-scale privatization
- Governance and enterprise restructuring
- Price liberalization
- Trade and foreign exchange system
- Competition policy
- Banking reform and interest rate liberalization
- Securities markets and non-bank financial institutions
- Infrastructure reform

An example of this can be found in the country of Iran, the author of this thesis's birth country. It follows the implementation of changes toward a free economy and the transition to a free economy. The transition of 825 privatization projects from phase zero to phase one. In total, 13 projects were privatized successfully, but 812 were unsuccessful and were returned to government control. Microeconomic stabilization and institutional reforms had little effect over 25 years. A successful transition or transition period cannot be guaranteed by making changes toward economic transition alone. It is also important to note that institutions like the International Monetary Fund have stated that transitional countries can experience inflation rates up to 1,000 percent. Due to the transition from the Old World to the New World, the Gini coefficient, a measure of income inequality, has increased to a number much above the 0.60 mark, a number greatly lower than that in the United States. Shocks, an important economic trigger, are one of the aspects that economic transition introduces and explains well, and it is one of the key elements of economic transition. By implementing sudden and drastic neoliberal reforms on a planned economy, shock therapy aims at transforming it into a free market economy. It is widely believed that shock therapy is a policy that is designed to control prices, provide subsidies, privatize state-owned industries, and tighten fiscal policy to achieve a desired outcome. A shock therapy policy can be described as a combination of a price liberalization strategy coupled with strict austerity measures in order to achieve an ultimate goal of economic recovery. A response to the Asian Financial Crisis in 1997 was shock therapy by the International Monetary Fund (IMF). Many supporters of liberal shock therapy believed it ended economic crises, stabilized economies, and laid the groundwork for economic growth. Others Joseph Stiglitz (Stiglitz, 2016, p. 17) said they caused them by deepening them unnecessarily. In other post-communist countries, Isabella Weber points out that the Washington Consensus (Weber, 2020) has resulted in an increase in excess mortality and a reduction in life expectancy as well as an increase in economic inequality and poverty, as Isabella Weber points out at the University of Massachusetts. In the years between 1941 and 1945, the Russian population experienced a higher death rate after shock therapy than at any time in its history. There was an increase of 0.9 Gini ratio per capita in all former socialist countries. Although some post-communist countries are still far behind their 1989 levels, the average post-communist country returned to 0.5 GDP per capita by 2005. In 2015, the real income of many people was lower than it was in 1991 due to this. It is impossible to create laws, regulations, and established practices instantly in a society that was once authoritarian, heavily centralized, and subject to state ownership of assets that were once owned by the state, according to William Easterly, to create successful market economies. Philipp Ther, a German historian (Kolář, 2020), said shock therapy contributed little to future economic growth. Having this shock repeatedly without following the previously mentioned stages can result in failures in transition; however, following the previously mentioned stages can lead to a fast and true transition. Long-term transition can only succeed if resilience is also implemented. Economic transitions require dealing with shocks. Four conditions must be met for inflation. A transition from a state-controlled economy to a private one followed, involving numerous economic transactions. Many economic corporations fail during this process because they are unable to be resilient. Economic corporations are businesses that remain in business for a long time. As a result of this process, a monopolist economy becomes a multipole economy. For organizations and communities to thrive and adapt in a fast-changing world, multipole economies build up their skill sets, instincts, abilities, processes, and resources through capacity building. Long-term capacity development requires an internal transformation generated and sustained over time. An innovative economy was found in countries whose institutional structures changed due to this transition. We will discuss the evolutionary economy as a bridge between transition economies and local factors in the next chapters. Transitions from major economies to market economies are not well understood. This chapter discusses the use of complex theories to explain the economy. A complex economy is the unique concept that focuses on local, human, and environmental infrastructure in the trade network. Prices are formed and changed by these structures. We tried to predict the future too much in economic transition and stimulated transition with more economic shocks to improve results. Today, we understand that economy has several layers that cannot be separated, so focusing on one economic stream cannot change all human interactions. Sustainability, feasibility, and resilience are the relevant interconnected concepts thus, shocks achieve resilience, and resilience is used to make the transition. By introducing shock into the system that causes resilience and then using the knowledge acquired as a transition stimulus, a better result can be achieved than by shock itself.

2.1.2. EVOLUTIONARY ECONOMY

There is a general consensus in evolutionary economics that evolution is not only a mainstream concept but also a dissenting approach to economics. In economics, interdependencies, competition, growth, structural changes, and resource constraints are strongly emphasized, but the approaches taken to analyze them differ from mainstream economic analysis in order to capture the complexity of these phenomena. As a result of the actions of diverse agents in an economy, evolutionary economics examines how firms, institutions, industries, employment, production, trade, and growth are transformed.

Evolutionary economics examines how different ideas generate and test more survival value than competing alternatives, leading to technological and institutional innovation. Adaptive efficiency can be defined as economic efficiency based on the evidence. Economics is concerned with scarcity and rational agents (i.e., agents whose goal is to maximize their welfare). Economic systems have been regarded as evolutionary throughout the development of complex economics. There is no fixed object of choice or fixed decision-maker in evolutionary economics. Taking non-equilibrium processes as a starting point, this study explores their implications as well as how they transform the economy from within. As a result of the interactions among diverse agents with limited rationality, these processes evolve as they interact and learn from experience, in which case diverse agents with limited rationality contribute to the evolution of the process due to their differences in beliefs and values. In addition to Darwin's evolutionary methodology, and the principle of circular and cumulative causation in non-equilibrium economics, this subject draws upon recent developments in evolutionary game theory and evolutionary methodology. Taking a naturalistic approach towards economic change, it is not possible to surmise that it facilitates or enhances human welfare in a teleological manner.

A rational choice theory can be explained by applying economic principles to evolutionary psychology. Alternatively, utilities, for example, could be seen as preferences that were made in the ancestral environment with a view to maximizing evolutionary fitness rather than necessarily being made in the present environment.

In 1898, Thorstein Veblen coined the term "evolutionary economics." Veblen (Hodgson, 1998) understood the significance of acknowledging cultural variation; he recognized that there was no universal "human nature" to explain the variety of norms and behaviors that anthropology demonstrated as the norm rather than the exception. In the end, Veblenian dichotomies were interpreted by later writers as "ceremonial/instrumental dichotomies" (Hodgson, 2004); Veblen argues that cultures have a material basis and that they depend on tools and skills to support their "life processes." However, each culture seems to have an elaborate status system ("invidious distinctions") that contrasts with the imperatives of the "instrumental" aspects of group life that govern each of them. As of defined Jack Downie and Edith Penrose word development (Nightingale, 1993), the German word "Entwicklung," which can be translated as development or evolution. This word has been translated as the development while the Schumpeter himself then stated Evolution in his English lecture at the Harvard.

When evolutionary economics was in its infancy, it was believed by economists that the theoretical frameworks that were then standard at that time did not adequately account for the empirical phenomena they were studying. Two topics were the focus of this early work. As a result, based on the analysis of industry behavior based on the then-prevailing firm theory, they concluded that the empirical studies of how firms made decisions were not consistent with the theories that were then prevailing. Aside from that, it should be pointed out that it did not follow what was known empirically regarding the structure and dynamics of industries or make use of these findings. Schumpeter's analysis made much more sense in industries where technological innovation played a significant role compared to standard formulations (Freeman, 1987). According to the conventional view of the time, technological progress and its role in driving economic progress seemed insufficient. New neoclassical growth theory highlighted this issue while standard microeconomics was silent. Nevertheless, the study described it in a way that appeared to be in utter dissonance with the empirical evidence presented in the research on how technological advancement occurs, which illuminated the uncertainties involved (Nelson et al., 2018). Consequently, it made little sense as an explanation of what was known empirically about the growth of economies during the industrial revolution, which was characterized by Schumpeter's idea of "creative destruction", rather than the smooth equilibrium path assumed by the new growth theory. Although dominant theoretical perspectives dominated these two areas, economic actors could not accurately perceive the alternative courses of action available. When economic actors innovate, they often take a new approach. Traditions repress the importance of adapting courses and learning from experience. In the past few decades, evolutionary economics has undergone a dramatic evolution. The determinants of economic activity and structure have been extensively studied and incorporated into the thinking and research of evolutionary people.

It is important to note, however, that most economists and social scientists do not consider themselves explicitly evolutionary in orientation. A variety of arguments and empirical findings applicable to the subject matter of evolutionary economics' research are cited in the evolutionary economists' proposition that the economy should be viewed as evolving over time. As part of its explicit recognition of the diversity of behavior among economic actors in similar environments, evolutionary economics has always been characterized as a field which recognizes the behavior of economic actors. A major stimulus for the development of evolutionary economics was early data on firm behavior and performance within an industry. There is a need for an explanation of differences between firms and industries based on the facts. At the time, the neoclassical theory could not adequately explain firms in terms of their capabilities and behaviors.

2.1.3. urban transition

International aid agencies and developing countries will likely face increasing pressure to rethink their development strategies as urban populations grow and rural and urban interests begin to overlap. Developing countries and agencies must be prepared for emerging trends by relying on scientifically sound demographic estimates if they are to engage effectively with them in order to succeed. To plan for the future growth of the city, the city authorities require accurate forecasts that are free from systematic biases. A city is also a primary unit for policies that have significant environmental benefits on a local and global scale, such as the collection and treatment of waste, microeconomics enhancement strategies and social capacities. Furthermore, because city managers are responsible for making decisions regarding infrastructure, transportation systems, and purchasing policies daily, they also possess a great deal of purchasing power. In many cities, some industries emit significant amounts of greenhouse gases (GHGs) or significantly impact the environment (Bai & Shi, 2007). There is no doubt that urban environments have become crucial arenas for addressing sustainability issues as a result of climate change (mitigation as well as adaptation) (Bulkeley et al., 2011). Cities have also been referred to as hubs of radical innovation and considered potential engines of sustainable development (Rotmans et al., 2000) since they are also considered potential engines of sustainable (Bulkeley et al., 2012; Ernstson et al., 2010). These days, municipalities are more than merely providing economic growth opportunities and social utility services; but are also playing an essential role in addressing sustainability issues (Burström & Korhonen, 2001).

There is an increased awareness that the urban sphere is a critical point of leverage for addressing significant challenges like climate change (Betsill & Bulkeley, 2007), so it is becoming increasingly important to take action to address them. Even though cities may not be the exclusive loci of sustainability, they can still play a significant role in advancing sustainable transitions and sustainability, even though they may not be the only places to accomplish such things. They can also act as hubs for low-carbon innovations in transport, waste, and water systems within their communities (Geels, 2011). In addition, the community is the scale at which it is possible to directly influence a person's behavior since a community is at the level of the individual (Bulkeley & Betsill, 2005). The city, as a component of green growth, is increasingly being recognized as a critical component of tackling climate change (Rosenzweig et al., 2011a) and promoting sustainable development (*13181_CitiesinaPost2012PolicyFrameworkCli.Pdf*, 2012., p. 52). There are still obstacles to overcome despite the fact that global issues can be addressed at the local level, despite the necessity, potential, and effectiveness of doing so. In order for cities to act on (for example) climate change, there are several barriers (often intertwined) that prevent them from taking action on those issues. While it is true that making scalable changes in sustainability at the city level will make fewer influences on the complexity and uncertainty of the multiple actors, interests, interactions, and processes involved (Ernstson et al., 2010), that approach is not enough. A city faces a number of complex and persistent challenges that have to be addressed in order for it to succeed. Cities must learn how to overcome the barriers that come with this (perceptual) dimension of space in order to be able to make a significant impact on major issues concerning their immediate environment. The scope of the issue in terms of time, the scope of the organization ('It is not my business,' local autonomy is too limited to act effectively), and the scale of institutions ('it is not my business)(Bai & Shi, 2007), all of which are important. It is not only the sustainability of a city or a city that presents its contested nature but also its contested nature. As a result, sustainability is a target with different meanings and aspirations for every city, making it even more challenging to find governance measures and mechanisms to accomplish it, as the place manifests sustainability in different ways. Accordingly, local authorities are transforming from simply regulating or providing services to enabling action on significant issues linked to environmental and sustainability issues, and there is a movement away from strictly regulating or providing services (Bulkeley & Betsill, 2005). (Seto et al., 2010) claim that because of forces of agglomeration, increased innovation, and increased wealth, rapid urbanization can speed up the transition toward sustainability. For urban growth to be successful, suitable governance structures must be in place. It is important to note that transition is not the result of the process. It is a constant process of improvement and advancement that leads to the survival of a system as a whole. According to the economic transition theory, if the system does not change, it means that there is not enough knowledge about it, as had been mentioned earlier in this article.

It has been shown that culture, structure, and practices are fundamentally altered during transitions (Frantzeskaki & De Haan, 2009, p. 11). The contemporary concept is formally linked to a specific objective of sustainable development (Rotmans et al., 2000), compared to historical transitions, which are characterized by radical and structural change processes without clearly defined and predetermined objectives (Geels & Schot, 2007a). A technology transition involves the introduction of new technology along with changes in markets, user practices, infrastructure, cultural discourses, policies, and governing institutions that are all part of the process of technological transition. Different structures and practices are co-evolving with one another in this system and its subsystems, resulting in dynamic interactions and co-evolutionary processes over time (Geels & Schot, 2007a; Kemp & Rotmans, 2004). Since transitions, as their characteristics indicate, are long-term processes (transitions approach thinks in terms of generations), guided by visionary ideas about desirable, sustainable system configurations, which are the result of these characteristics, they are long-term processes (transitions approach thinks in terms of generations). In historical transitions, it has been shown that it is people's ideals that catalyze a transition (such as the ideals and ideas of during the Dutch agricultural transition, Grin, 2012) (Kivits et al., 2010). It has been proven that technological developments have contributed to a wide range of sociopolitical (Kivits et al., 2010), infrastructure (Automotive transition, Nykvist (Nykvist & Whitmarsh, 2008), environmental changes as well. When pilot projects are shared and communicated to policymakers, their benefits and outcomes are clarified, and they result in innovations that are aligned with future policy goals, (Van Buuren & Loorbach, 2009) believe they can serve as seeds of transformation in policy contexts. There is a sense in which they are viewed as a basis for influencing, initiating, or stimulating processes and conditions that can lead to sustainable development on an ongoing or new basis. In addition to these elements, transition management is a process-oriented framework. This approach is known as transition management (Loorbach, 2007), which utilizes a coherent framework for systemic change in order to empower and mobilize the undercurrent of sustainable development through a coherent framework for systemic change in order to empower and mobilize the undercurrent of sustainable development. As well as focusing on learning and system innovation, it considers multiple domains and different actors as part of it (Rotmans et al., 2016). At first, the transition (management) approach has been mainly applied at the national level to research and practical experience as well as sectoral policy transformations (e.g., energy, water, mobility, building, and material use) at the national level. This evolution has resulted in growing importance for local action regarding major sustainability issues such as climate change, and cities (for example) must develop sound scientific knowledge on how to combat climate change effectively and efficiently (Rosenzweig et al., 2011b). Consequently, innovative approaches are not only focused on content-related issues (technological deployment, behavioral change incentives), but they are also focused on process-related issues (governance, participation, co-creation, and collaboration) in order to achieve the desired results. The concept of space has been introduced as a new empirical ground in transition studies over the last few years. In recent scholarship on urban transitions, conceptual transition models have largely been used in a meaningful way to examine urban contexts in a meaningful way. An area can be defined in many ways, including as a neighborhood of homes and businesses with similar development patterns or as a district used for a single purpose. There are shopping centers, campuses, corridors connected by roads, water, and rail to the neighborhood, as well as public spaces like parks, plazas, streets, sidewalks, squares, waterfronts, and markets. In a city, a place is referred to as a public space, or an open space, that is accessible and treasured by all and has a unique heritage, cultural identity, and social identity unique to that area. Even though urban planners, designers, and landscape architects are increasingly using public spaces in cities to improve social, economic, and environmental outcomes, these places need to also be resilient to disasters in order for them to be successful. Therefore, local governments should be able to plan and design places that will allow them to anticipate disaster risks in the future better, thereby further enhancing the resilience of cities in the future. In general, resilient cities are viewed as transit-oriented developments of eco-cities and eco-efficient dwellings, which include smart infrastructure, local food production, and pedestrianization. Due to the high level of construction in cities, developing robust built infrastructure and land use planning are considered crucial to developing resilient cities. Even so, developing a resilient built environment and land use plan are not the only factors determining a city's resilience. As rooted in resilience thinking, creating resilient cities draw attention to the unpredictable and uncertain future, particularly concerning climate change and complexities arising from the dynamic behavior of multiple interacting components or systems in a city, such as the physical built form, the environment, and people as they relate to each other. As a result of these complex relations, cities are vulnerable to shocks and stresses. However, resilience thinking also acknowledges that there are opportunities to enhance the ability of city systems to respond and respond to shocks and either return to their normal state (bounce back) or adapt and change to a new normal state (bounce forward). Therefore, resilience thinking is an essential element of understanding city vulnerabilities, as well as influencing future city planning. It is also important to note that a place's resilience is not solely determined by its vulnerability to the environment but also by the capacity of the community to resist and adapt to changes through the application of mitigation and adaptation measures. a direct correlation between the resilience of a city, individuals, families, and communities, as well as institutions and built environments, exists. To make resilient cities, it is therefore essential to pay particular attention to diversity, cohesion, adaptability, and efficiency as a part of a place-led agenda. A city's diversity is a reflection of its ability to understand the many different behaviors, forms, and functions of the city systems within it. As an example understanding the diverse needs of the community and developing places that can serve a variety of functions. Creating a sense of local identity can be achieved through a sense of community. cohesion implies a sense of unity among the residents. The ability to adapt is the emergent characteristic of a city as it recognizes the multiple interacting components that provide the opportunity for learning within a city system. Local governments can identify problems by learning lessons from disruptions, plan and prepare for disruptions, and mobilize assets and resources to respond and recover more effectively. Understanding the vulnerabilities and risks in cities will also allow local governments to plan and manage the development of city public places to minimize these risks. efficiency is related to cost-effective ways to deliver city functions and services and community satisfaction resulting from mixed-use developments.

Scotstown (Geels & Schot, 2007b) owes its name to the phrase "Think global, act local," which has been attributed to it for many years. This concept is defined in this context, which means that all members are given access to a science that is capable of enabling them to comprehend meta-trends and utilize this knowledge in a way that impacts the daily activities of local communities in a manner that is beneficial to the global community as well. The city is a complex system, and as mentioned earlier, it cannot be reduced to a set of relationships, nor can its behavior be predicted in advance. Using long-term data, we can draw a general picture of how different members in a city interrelate with each other and the different aspects of this complex system in the analysis of long-term data. In the writer's opinion, it is not necessary to create a new prediction system or control panel for city structures. However, it might be possible to introduce a monitoring panel based on a new approach that provides a score to different relationships and emphasizes different layers, intersections, and layers of relationships.

3. Resilience

In recent decades, resilience has been applied in a variety of settings (psychiatry, psychiatry, ecology, social science, economy, and engineering) (Renschler et al., 2010b, p. 23)Recent years have seen an increase in attention paid to risk management ((Renschler et al., 2010a), (Carlson et al., 2012). The resilience is better frame if we define it is a capacity of the substance (economic, psychological, physical and etc.) to find relative treat and respond them in appropriate shape while the existence of the substance is granted. resilience is a phenomenon which can't assess unilaterally, this leads us to more specific resilience strategies which addressing the issue at the time and place. The concept of resilience can be further defined in terms of specific measures of resilience, such as critical infrastructure and economic resilience, which are valuable as independent determinants of resilience but are also beneficial in their roles as components of resilience at a broader scale, for example community or regional resilience (. We are assessing resilience in term of its values, counter effects and the feedback from the system. This is why, from a point of view, it is less important to draw the line between indicators such as vulnerability and resilience than it is to be able to develop a process for measuring these indicators that can produce results that are consistent, reproducible, and are useful to decision makers in identifying potential threats and identifying potential solutions. In order to create a comprehensive approach to risk management, one of the most important elements is the development of a clear and consistent method for distinguishing and measuring resilience. Establishing a working definition of resilience is the first step in developing that process. A resilient entity is one that anticipates, resists, absorbs, responds to, adapts to, and recovers from a disturbance — whether it be a facility, an organization, a community, or a region.

In our analysis and proposed approach to measuring and evaluating resilience at both the facility and the community, we use this definition. Prior to an adverse event, actions focused on anticipating, resisting, and absorption are taken, while afterward, actions focused on responding, adapting, and recovering are taken. Activity/well-being declines based both on the amount of resilience of the object of analysis and the time it takes them to return to pre-event equilibrium (or some other equilibrium). A facility's resilience (i.e., its ability to withstand and rebound from an event) can be measured based on a variety of measures, according to what we define as resilience.

Among them are:

- Preparedness (anticipate) - Mitigation measures (resist, absorb),

- Response capabilities (respond, adapt), and

- Recovery mechanisms (recover). (Carlson et al., 2012)

Resilience cannot be defined without these fundamental notions. Defining the hazardous environment in which an entity operates is known as "preparedness." In order to address the problem correctly, we must first identify the underlying factors that contribute to it. During mitigation, a person undertakes or develops activities, tasks, programs, or systems to minimize or prevent the effects of an adverse event. This includes the activities a person takes part in before the event occurs. It is therefore essential to respond immediately, to develop a program, and to change the system. In such a case, it can be resisted or take on an entirely new appearance. As a second phase, efforts must be made to restore the entity's condition to an acceptable level as quickly as possible. An evolutionary approach to systems is at the core of our definition of resilience. In the Covid pandemic, societies responded quickly to a big shock and absorbed a portion of the risks, then resisted the pandemic and absorbed the rest, then recovered from it. However, it is unclear whether people will continue to live the way they did before the pandemic, after recovery and this process. According to the effects of World War II and previous disasters, the situation will not be the same as before the pandemic. While some elements have become less important, others have become more important.

3.1.1.Resilience definition, theory, and challenges

Politicians and policymakers alike use the term 'resilience' as a common reference point when discussing public and social policy initiatives. In a similar way, academic interest in this concept has spread across a range of seemingly dissimilar academic fields, reflecting its broad rhetorical and intellectual appeal as well as its opportunity to be interrogated theoretically and practically. The argument that society, the economy, cities, or infrastructure should be less resilient is illogical from the perspective of a planner or a politician. Academics and policymakers have quickly incorporated this serviceable acceptance and burgeoning normalization into their lexicons. Regardless of the challenge, resilience appears indefensible, representing an aspirational goal. The development of this concept also has been deeply explored (Brand & Jax, 2007) and widen its potential application. To appreciate the intricacies of resilience, one should pay attention first to the concept's genus and germination. The term's origins can be traced to ecology and natural science (Walker & Cooper, 2011). However, resilience has since been adopted by a multitude of broader disciplines, from psychology and psychiatry (Kaplan, 2005) to social and community development (Adger, 2000) to engineering and design (Bosher, 2008). Within spatial planning, resilience has been most discussed as a normative concept to build capacity to manage specific risks, including climate change Communities and Local Government (CLG), (Klein et al., 2003), terrorism (Coaffee & O'Hare, 2008), flooding and drought (Zebrowski, 2020), and economic and regional decline (Hudson, 2010). Therefore, from relatively discrete beginnings, resilience now has potentially profound implications for theory and practice. In contemporary debates, it is a commonly held view that resilience is concerned with the ability to cope with stress or, more precisely, to return to some form of normal condition after a period of stress. Early on, the ecological theory was associated with the equilibrium and stability of ecosystems. It was Holling's seminal paper in 1973 (Alschuler, 1986)that challenged the notion of a single equilibrium and stability, and he advocated resilience, a concept that he defined quite precisely: "Resilience determines the persistence of relationships within a system and is a measure of a system's ability to adapt to changes in state variables, driving variables, and parameters." Resilience has deeper roots in psychology than ecology, according to Perrings (Dey et al., 2012). In 1998, he identified resilience as the ability of a system to withstand stresses and shocks.

In recent years, resilience has been used by psychologists to describe how individuals cope with potentially traumatic events. The focus has shifted from individual resilience to social capital in the communities in which people live. Developing resilience theory in the context of socio-ecological systems can potentially be co-developed with community resilience research. Community resilience research comprises insights into health and human development. The notion of resilience has become increasingly prevalent among interdisciplinary scientists interested in sustainable development and has been defined as follows by these scientists: "The ability of human communities to withstand external shocks or perturbations to their infrastructure, such as environmental variability or social, economic or political upheaval, and to recover from such perturbations."(Adger, 2000)

As far as disaster management is concerned, the definition is in favor of shock and absorption in this way, and we can rely on the definition of "Series of functions and algorithms to minimize risks during and after shock events". According to theory, resilience can be defined as making two points in time at a given point. Before and after the event, both before and after the event. In order to define resilience, we need an understanding of the type of shock we are facing at the moment. A uniform shock, such as chronic events, when analyzing resilience, is analyzed differently on different scales based on the frequency of the event. On a social scale, they are comparable to detachment from the family, social humiliation, economic shocks, and long-term recessions that lead to chronic stress and depression. In order to describe resilience, one of the main aspects that need to be addressed is how to describe the shock. As a result, if we consider the shock as an acute shock, we have already analyzed it at the anticipation stage, but we may encounter some challenges at the mitigation stage if we treat it as an acute shock. There is no doubt that recovery is the most important aspect of chronic stress, however. It is essential to mention, that the recovery process does not involve returning to the point where we were before the shock occurred. Depending on the complexity of the system, it is not possible to revert to the stage before the shock, or the conditions before the shock are not available because of the complexity of the system. When studying resilience, it can be difficult to determine when a matter begins and ends. A system's resilience is also determined by how the system is described. It is believed it is imperative to understand the small parts and how they relate to each other when one is living in residence. The formation of systems is a subject that has been the subject of numerous research papers in the past few decades. Resilient infrastructure is one example of a resilient system. it is because there is a great deal of information that can be found about resilient infrastructures. The next aspect of a resilient system is the human element. Is the human only a user in this cycle, or does it form part of a subsystem? As each network has attachments to subsystems of the next, it is impossible to distinguish one network from the other, as this chain of connections allows the system to progress to a higher phase. It is evident that separating the human from the system is equivalent to separating an organ from the body and cannot be a sustainable solution in the long run. In a resilient system, there is also a description of how the system is analyzed. Because resilience is a retrogressive concept, it can only be calculated after the problem has occurred, which makes it difficult to make an analysis indicator prior to the shock. Although shocks create new trends based on the evolution and progression of systems in a way that if we consider social shocks as indicators in analyzing social resilience of the present time, societies are resilient to a great deal, which is not the case since numerous new stress factors in social networks and the possibility of numerous new shocks exist. New risks are associated with the new society, and it is possible to know this in advance. Consequently, analyzing the resilience of past systems is not sufficient but only reduces the context to smaller underlying factors. We in this research primarily on the social, economic, political, and biological aspects of the whole system. Thus, a dynamic resilience theory is primarily concerned with evolved shocks and evolved systems.

3.1.2. Urban resilience

Recently, the concept of "resilience" has gained increasing popularity in the academic and policy discourse and has been explained in various ways (Meerow & Newell, 2015). Considering climate change and complex socio-ecological systems, resilience theory has no doubt provided insights into these systems. Socio-ecological resilience theory has an important role to play in dealing with future climate uncertainties since it recognizes that ecosystems are constantly changing in nonlinear ways. It has a positive societal connotation as opposed to related but more charged concepts like vulnerability, which researchers suggest is a more appropriate term than resilience (Weichselgartner & Kelman, 2014). A beautiful perspective regarding resilience can be gained from the perspective that cities are highly complex, adaptable systems. During the past three decades, unprecedented urbanization has transformed from 10 percent urban by 1990 to more than 50 percent urban today (United Nations Department of Economic and Social Affairs, UNDESA, 2010). Urban areas (with a population of at least 50,000) cover less than 3 percent of the Earth's surface but still account for 71 percent of the global energy-related carbon emissions, even though they cover less than 3 percent of the Earth's surface. As a result of uncertainties and challenges such as climate change, urban resilience will become increasingly important in facing these challenges (Carmin et al., 2012; Leichenko, 2011). Despite this, what is the exact meaning of urban resilience? As we discussed earlier, the word resiliency comes from the Latin word resilio, which means "to bounce back" (Klein et al., 2003). Even though it is an academic concept, its origins and meaning are unclear (Friend & Moench, 2013; Lhomme et al., 2013, 2013; Pendall et al., 2010). It is believed that resilience is characterized by a certain amount of conceptual fuzziness, which enhances the ability of resilience to function as a "boundary object," a concept or object that appeals to a variety of different "social worlds" and, thus, facilitates the collaboration of scientists from several disciplines (Star & Griesemer, 1989) . In addition to being a flexible concept, resilience allows stakeholders to come together around common terminology without necessarily agreeing on an exact definition (Brand & Jax, 2007). It is because of this vagueness that resilience is difficult to operationalize or to develop generalizable indicators or metrics (Arnold & Gunderson, 2013; Vale, 2014). Five tensions are present in the first five of those: 1) equilibrium resilience and non-equilibrium resilience; 2) positive and neutral conceptualizations of resilience; 3) the mechanisms of system change (permanent, transitional, or transformative; 4) adaptation versus general adaptability; and 5) the timescales of action. There is a debate in the urban resilience literature about how the concept of 'urban' is defined and characterized. To incorporate resilience into urban research and policy, it is crucial to come to terms with these tensions effectively. Moreover, we propose a new definition for urban resilience, which explicitly incorporates these six conceptual tensions while at the same time remaining flexible enough to be adopted by a wide range of disciplines in order to achieve a broad definition of urban resilience.

A definition of urban resilience can be summarized as follows: urban resilience refers to the ability of an urban system, as well as its constituent socio-ecological and socio-technical networks, across spatial and temporal scales to maintain or rapidly return to desired functions in the event of a disturbance, to adapt to change, and to transform systems that cannot adapt in the future quickly. There are multiple pathways to resilience in the definition of urban resilience (e.g., persistence, transition, and transformation). There is an emphasis on general adaptability rather than specific adaptability. As a result, it recognizes the importance of considering the scale of time as well. Urban systems are conceptualized as complex and adaptive systems made up of a set of socio-ecological and socio-technical networks that extend across multiple spatial scales. As defined by (Meerow & Newell, 2015), urban system resilience is the ability of an urban system, as well as all of its constituent socio-ecological and socio-technical networks, to maintain or quickly return to desired functions despite a disturbance, adapt to change, and transform systems that have a limited ability to adapt in the future or present. After the report of the World Commission on Environment and Development Our Common Future in the 1990s, evidence indicates that sustainability gained popularity among academics, practitioners, and politicians. WCED explains sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs in the future" (Sikdar, 2003). Although sustainable development has been popular, it has also been subject to considerable criticism because it relies heavily on human-centered approaches that are often associated with the hegemonic economic growth vision of hegemonic economists (Naredo, 2004; Ruggerio, 2021), as well as for its ambiguity and diversity of interpretations (Mebratu, 1998; Naredo, 2004). Sustainable development is often confused with sustainability. In order to define sustainability, Ruggiero suggests three criteria that he considers to be important: "

a) incorporate economic, ecological, social, and political factors into the analysis of socio-ecological systems in order to account for their complexity; (Ruggerio, 2021)

b) incorporate equity across generations as well as equity within generations.

c) Taking into account the hierarchical organization of nature, that is, acknowledging the interaction between socio-ecological systems and their environments, is a necessary step towards understanding this phenomenon." A socio-ecological system is also constantly changing, so it can either be sustainable or unsustainably sustainable. As far as sustainability is concerned, it is typically referred to as an ability for something to remain durable and stable over time. Sustainable development does not mean being self-sufficient; it means acknowledging the ecological system outside one's borders as an integral part of one's own ecosystem. The Sustainable Development Goals (SDGs) of Agenda 2030, adopted by all U.N. members and implemented both on a national and local level in many countries, are being developed into a sustainability action plan. In SDG 11, which focuses on making cities inclusive, safe, resilient, and sustainable, resilience is explicitly discussed, but other than that, sustainability is not specifically mentioned in the goal. The existence of sustainability is therefore predicated on resilience.

3.1.3. Resilience in Urban economics

As a result of the urbanization process, economic development is now driven by cities, which present growth opportunities. Furthermore, the country faces numerous internal and external challenges, such as poverty, migration, pollution, decay, natural disasters, and the current economic crisis. There is a tendency towards transformation in every city, therefore. These internal and external challenges are also associated with the transformation of post-industrial areas, perhaps most profoundly. It is important to note that some industries will be able to adapt to such problems (challenges), while others will decline due to structural change. As a result, urban and economic resilience provides a concept that is understandable and manageable. Urban and regional studies have been introduced to the concept of resilience by the debate about sustainable development and climate change adaptation (Simme, Martin, 2009). The resilience of urban areas has also been triggered by major urban disasters and threats in recent years, such as the terrorist attacks in New York, the tsunami and Hurricane Katrina in New Orleans, as well as the bombing attack in London (2005). Similarly, urban resilience can be characterized as the ability of cities to tolerate disruption before reorganizing around new structures and processes (Alberti et al., 2003). Consequently, urban resilience is not only the ability to respond to impacts (such as a natural disaster or economic decay) but also the ability to adjust to uncertainty as a society and economy. Therefore, urban resilience can be defined as the ability of a city to anticipate, prepare for, respond to, and recover from a disruption ((Barnett & Busse, 2001; Foster, 2007). In urban economics, resilience refers to the ability to solve local economic problems in such a way as to achieve long-term success. (Simme, Martin, 2009) Local and regional development are often disrupted; therefore, a flexible economic structure in a context where disruptions are absorbed results in a change in structure, referred to as transition, which is a measure of the level of urban economic resilience. As a concept, agility and homogeneity are essential components. Agility refers to the ability of a context to respond rapidly to shock to minimize its effects. The aim of sustainable urban transition is homogeneity, which is translated into inclusiveness in the urban context ((Barnett & Busse, 2001; Leyenaar, 2005; Zoppi & Lai, 2008; Varma, 2011; Ferreira, 2020)). It is unlikely that the resilience of the urban economy will remain constant over time. This gives space equilibrium and evolutionary theories more space. In this thesis, we are following an evolutionary scenario. The idea of a complex system can be addressed on multiple equilibrium or evolutionary grounds. In the evolutionary scenario, there are four pillars to address urban economic resilience, first looking to adaptation possibilities, namely Darwinism. In light of this definition, urban context adapts itself to the agents with the highest capacity. Thus, the strongest will form.

Furthermore, lock-in is a consequence of looking at the subject merely through the lens of path dependency. This path is either a self-created resilience scenario, namely engineered resilience, or a hesitation on adaptation due to a lack of possible innovative scenarios. Scholars such as (David, 2005) suggested these options as positive and negative resilience, respectively. Complexity theory is well-known for adaptation and uncertainty. This theory is closely aligned with the urban setting with a network of interconnected agents. In this Ph.D. thesis, the author emphasizes the complexity of the setting and the complexity theory for urban economic resilience. Consequently, subsequent chapters of the thesis conduct mathematical models aligned with the Resilience Alliance Initiative suggested in the 2007 model in order to analyze and illustrate the conceptual framework. The metabolic model is discussed in Chapter two, where innovation networks are suggested as an alternative to a production and supply chain perspective. Chapter two elaborates on networks and tests them in an urban setting using regional-level data for governance and community-level transactions. This project examines social dynamics, specifically in chapter three, where the Boston case study is presented. It is important to note that all of these efforts are directed towards the physical environment and the ecosystem in order to define the city transformation as an outcome of the economic transition with resilience in this particular setting.

3.1.4. Resilience as the principal property of transition

Resilience, transition, and transformation are the three levels of adaptation identified by Pelling, which differ mainly in their degree of challenge to status quo. The desire to maintain functional integrity is what defines resilience in Pelling's classification. A "adaptation as resilience" approach may allow unsustainable or unjust practices to continue by improving existing practices without questioning underlying assumptions. The best way to serve established values is by providing short-term and partial remedies. Sociopolitical regimes, norms, and principles remain the same regardless of governance systems. Rules and decision-making may change, but norms and principles remain the same. It is possible to re-negotiate policy priorities during the transition process, as well as frame problems differently. Values must be questioned from individual behavior to global political economy's mechanisms and structures in order to shift the paradigm of global political economy. When society is transformed to understand the environmental crisis as a reflection of our relationship with the earth, the root causes of vulnerability and deprivation are addressed. It echoes Freire's statement (Alschuler, 1986) that "... we are not only 'in' the world, but also 'with' it, which means that we are fundamentally connected to it." The environmental crisis has distorted our relationship with the environment. Social-ecological relationships need to be shaped differently based on a different view of nature and society. Our worldview must change profoundly in order to accomplish. For the dominant capitalist production system to be sustainable, the public/private dichotomy must be changed to benefit private actors and marginalize government. In Pelling's view, each form of adaptation involves social learning, but there is a difference in focus and outcomes. Engaging with civil society and taking risks are prerequisites to change, so when it comes to transition and transformation, it also encourages organizational changes and institutional reforms. When an organization has solid levels, institutional inertia inhibits change. Transition and even transformation can occur as a result of emerging social structures. Toward a deliberative democracy that transforms, Pelling argues (Leonard & Pelling, 2010) that it requires critical reasoning. In order to engage in dialogue with those in power, marginalized groups can use Freire's pedagogy of political pedagogy. Embedded values must also be challenged through transparency. Knowledge of complex social-ecological systems and their nonlinear interactions at multiple scales is limited. As a result of this complexity and uncertainty with incomplete knowledge, a paradigm of adaptive management was developed. Through deliberate experimentation, continuous monitoring, joint actions, and reflective practice, scientists, resource managers, and policymakers learn to make better decisions. Although this has been true, social-ecological systems theory has been criticized for not being politically involved and being power-blind, overlooking power differences among actors. Increasingly, environmental movements as well as indigenous communities are becoming increasingly important in resource management, so the learning process has begun to incorporate what is known as "local knowledge" or "lay knowledge." Identifying practices that are restricted to professionals and those that are incorporated by a wider variety of actors is crucial to opening social learning up to a diversity of world views and a questionable set of values. Collaborative management developed as rights-based approaches to development and greater participation in resource management gained traction. As a part of resource management, a wider range of actors must be involved in decision-making, which implies a need for training. Sharing knowledge, perspectives, and values in a trusted environment is what social learning is all about in this context. Although power and knowledge imbalances can seriously affect the outcome of such processes, as well as practical considerations such as time constraints and attendance variability, they are generally not fatal.

Adaptive and collaborative management are also characterized by learning and action. Living, working, and enjoying leisure activities sustainably is one of the main challenges of our time. Despite the many initiatives on a national and international level to work towards increased sustainability and reducing our societies' global footprint, there continues to be an increasing global demand for natural resources related to water, land, and energy consumption, as well as persistent social and economic inequality. In the sustainability science discourse, sustainable transitions are transitions that are oriented toward sustainability goals. It is therefore possible to describe sustainability transitions as 'long-term, multidimensional, and fundamental changes in society and technology aimed at achieving a more sustainable future.' Efforts to enhance a system's overall sustainability are achieved through technological, social, or political interventions. Compared to sustainability transitions, other historical socio-technical transitions differ in many ways. Sustainability transitions have a vision of creating a more sustainable system state, which results in a goal-oriented normative perspective. The change in technology has prompted scholars to emphasize the need to change our societal structures, routines, and cultural practices. Managing and integrating such changes requires consideration of interactions among the social, ecological, and technical subsystems. Understanding when and why sustainability transitions succeed or fail becomes paramount since there is broad agreement on the policy side that a more sustainable society would be desirable. For this purpose, sustainability transitions must be viewed holistically and comprehensively. A more sustainable society can be achieved through each theory of transitions and resilience. A key aspect of transition is resilience, as we discussed earlier. Three steps make up a conceptual model. This is a conceptual model of sustainability. As stress factors produce new norms, we can conclude that urban resilience and urban transition occur gradually and over time. It therefore possesses its own economic, social, and physical infrastructure capable of adapting to new conditions. Changing processes involves transformation as the third step. An identity transition is characterized by a change in appearance. Identity transitions are guided by a framework of resilience. A framework for managing the transition can be gained by improving and shaping the concept of resilience. We recognize resilience as a key property of transition. When social and political communications are designed to identify stresses and shocks in urban areas, they can be used to determine the new needs for change for a better life. As long as the human being is recognized as an integral part of the space, and economic transactions are used as a method, social and political communications can identify stresses and shocks. Urban transition management is what it is.

For planning and modeling urban management, resilience is not considered a separate factor. In turn, it is an essential component of the concept. It is undoubtedly more effective to manage urban areas if resilience is incorporated into different mental maps and theoretical frameworks. As a result, resilience is the first of the three transformation factors. The resilience that we experience allows us to provide short-term and immediate solutions to fundamental problems to start a transition and implement long-term changes in the planning and management processes. Changes in economic, managerial, environmental, and social factors lead to transformations in themselves. Identify the shocks in the preparedness, make the best decision in mitigation, implement the decisions in response, and evolve the process during the recovery period. Therefore, the transition is achieved through the management of the transition.

3.1.5. Place Based approach in resilience

Cities have grown rapidly in size, density, and complexity in the past two decades as a result of accelerated urbanization, mainly owing to economic processes. There has either been an oversight or a compromise of social and environmental relations. Thus, we can see that many highly vulnerable cities around the world are separated from their natural environments, where two-thirds of the world's population live in marginalized and unsafe places. Natural disasters have a direct impact on human welfare due to climate change. Climate change is one of the biggest threats cities face today, as extreme weather events are becoming more intense and severe. Several cities and urban areas are located in hazard-prone areas such as floodplains and fragile coastal areas, where natural hazards are more likely to occur. Sea level rise increases their vulnerability as well.

The infrastructure of most developed cities is aging, built when building codes weren't prepared for today's intensity of storms. As a result, these built forms are more vulnerable to disasters due to their aging. A city is a complex and dynamic system, which operates at many scales, from a macro level to a micro level, and has interconnected infrastructure (built environment systems). A city's interconnected systems can create a domino effect when one system fails, disrupting or damaging others in a domino effect. Understanding how a city's infrastructure, buildings, residents, and culture are interconnected is essential to building disaster-resistant cities. Cities that have developed resilience are those that maintain essentially the same functions, structure, systems, and identities over time while absorbing shocks and stresses of the future.

Additionally, they are mitigating future shocks and stresses. Several international initiatives have been launched to increase the resilience of cities as policies and disaster literature recognize and accept resilient cities. UN International Strategy for Disaster Reduction (UNISDR) campaign to make cities more resilient and Rockefeller Foundation's 100 Resilient Cities (Zebrowski, 2020). Moreover, as cities grow, their social infrastructure and original residents become displaced, making them more vulnerable to disasters and compromising their resilience. It is either difficult to live in poor conditions in displaced areas or to live in isolation from their communities. The rapid urbanization as well as the desire for modern infrastructure have contributed to a sense of placelessness and emptiness in the area. Friedman argues that modernization destroys a city's unique identity and personality. As a result of economic prosperity, chains stores, restaurants, and high rises have homogenized places, reducing local diversity and making them unattractive and unpleasant" (Zukin, 2009).

In the United States, unequal power relations and unequal development have contributed to the erosion of public spaces. Toolis discussed how privatization of public places contributes to this erosion (Toolis, 2017). In light of this, it is crucial to use place-based approaches (PBA) to inform city planning by enabling people to connect with their places in order to ensure they are not only safe, but also livable and resilient. Being a part of a place or having access to it directly impacts social capital and establishing a sense of belonging, both of which increase psychological well-being. Local governments should consider making cities more resilient to disaster risks and placelessness in light of the increasing vulnerability of cities to disaster risks and placelessness. They should also strengthen social cohesion, identity, and connectivity among communities to strengthen their resilience to disasters. Despite its ability to transform cities, PBA operates independently from local initiatives that support municipalities' growth and resilience. There is a lack of linkage between resilience theory and social sciences, despite the fact that resilience theory is largely defined ecologically. The diversity of social science disciplines and theories has led to many concepts that resemble resilience, as well as many different conceptions of resilience. The ability of a community or group to cope with external stresses and disturbances is a definition of social resilience that (Adger, 2000) outlines in his definition. As (Almedom et al., 2015) use coherence models to conceptualize resilience, this concept has also been called "adaptability." Learning, trust, and engagement make up social resilience, according to (Arnold & Gunderson, 2013).

Cultural transmission of information is also implicated as a resilience mechanism, resulting in social and cultural capital. Recent years have seen an increase in interest in operational methods for assessing social resilience. Based on data collected from community surveys as well as independent characteristics such as infrastructure, Cinner and colleagues developed the adaptive capacity index for coastal communities. Based on surveys among Australian fishers, Marshall created a social resilience index (Marshall & Marshall, 2007) . According to reports, this approach has also been used to assess social resilience in resource users. Studies have been conducted in other fields. The adaptive capacity and coping capacity indices, as well as other indicators of social resilience at the household level, remain understudied. An organization's resilience is the capacity to cope with a disaster, emergency, or other adverse event within a short timeframe, including materials, assets, and resources. Adaptive capacity is composed of knowledge, skills, social memory, and expertise. Long-term transformations such as climate change and other long-term changes can be successfully adapted to by these components. Recent years have seen researchers study the development of social resilience indicators, but evidence from social science literature indicates that indicators are most effective when they are developed by or in collaboration with those who intend to use them to make explicit future decisions. As well as responses to social perturbations and shifts, context and nuances are crucial to quantifying social resilience. The concept of social resilience must be quantified in order to be used effectively in planning and policy. The idea is to create a space based on the occurrences of human activities in the environment. In order to ensure a city's resilience, local governance has new responsibilities. Humans and the environment interact dynamically through a dynamic, time-scaled process.

In this environment, each individual is described uniquely, thus forming different communities. A social culture is formed by a set of communities that are characterized by their economic behavior, economy, and governance infrastructure. In many contexts, policymaking is based on place, and this is a subcategory of policymaking. In order to achieve a place-based approach, it is important to include both human and structural factors as well as social justice. Place-based approaches to resilience are limited, yet calculated responses by districts to a great challenge, such as climate change or pandemics, are essential to a city's resilience. The general rule is that, when exposed to shocks and ongoing stress, cells are more resilient. The place-based approach integrates capacity building into the transition process and reshaping of urban spaces as part of the larger decision-making processes. For decades, local governments have been a key part of long-term planning in most of these organizations. It is important to them that local areas are taken care of. Localities have a sense of place in addition to their economic and political identities. It appears that residents of one neighborhood are more resilient than residents of others. A top-down approach to resilience used to be prevalent, in which residents were dictated resilience by authorities. The last few years have seen several international organizations significantly change this viewpoint to one that is more bottom-up. In order to prepare a complex system for transition, frameworks guide how to link parts of the system. The characteristics of a neighborhood contribute to the development of a sense of identity among people living there. As organisms evolve, they must take into account elements from their past. Evolution cannot take account of its past or change its usual growth pattern as long as it does not take into account its past. Creative destruction refers to the process of dismantling established production methods in order to replace them with new ones using resilience perspectives based on place.

This writing seeks to draw attention to a kind of exchange between traditional identity and traditional characteristics of an area and innovative ideas for its future development in a way consistent with its traditional identity and traditional characteristics. As a result, evolution is defined as learning from the past and changing for the better in the future due to those lessons. By using a place-based approach, it is possible to emphasize the phenomenon that city cells drift apart from each other over time. When a place that has a low historical identity or a weak economic position enters the system, it is forced to struggle once again. Due to this, we argue that a place-based approach is not necessarily an addon to the system management, however, it can enable different communities to share ideas about the future, not necessarily their traditional identities as a result. By doing this, the area will be able to create a social capital that will be capable of absorbing and adapting to the shocks and stresses that it has experienced throughout its history. As the method of analysis for each area of the study varies because the concept of tangible or intangible is perceived differently by people, it follows that the environmental, economic, and social problems of an area are going to be bold to the policymakers, as we will discuss in the final chapter. At the neighborhood level, this conceptual framework is aimed at developing a sense of identity that is ready for the transition, as well as developing a general transition policy at the city and regional levels. In order to highlight the value of a neighborhood to policymakers, a place-based approach is a suitable technique for doing so.

4. Managing Urban Transformation

In the opinion of urban planners, researchers, and the inhabitants of cities, urban planning has not yet reached the local level. Urban planning refers to the process of planning and designing a well-functioning urban environment and also to the direction that the city should be heading in its development. Planners have faced several challenges as a result of urbanization, however. There is much difficulty not only in predicting the dynamics of urban change and analyzing the causes of urban transformation but also in analyzing the reasons for it. Because urban environments are complex, making decisions about how to deal with them can be pretty challenging.

A key recommendation of the New Leipzig Charter (Simon, 2021) is that cities develop integrated and sustainable urban development strategies in order to transform society, as the charter emphasizes the role of cities in changing society. It is a strategy that is implemented both at the local and regional levels, from the regional urban hinterland to the very local level in neighborhoods. To accomplish this, a common good urban policy with inclusive infrastructure and services is imperative. In addition to serving as laboratories for inventions and test beds for social innovation, cities are also places of plurality, creativity, and solidarity.

In addition, it acknowledges a pluralistic, creative, and united city. In addition, it is a place where social innovation can be tested. Moreover, it promotes just, green, and productive cities. Just cities provide integration opportunities for everyone. Educating, providing social services, providing health care, and promoting cultural awareness should be available to all social groups. A well-balanced, mixed, and safe urban neighborhood enhances the integration of all social, ethnic, and generational groups and generations. European Union Ministers Responsible for Urban Matters (Armondi, 2020), emphasize the need for citizens to be able to acquire new skills and education. The purpose of a green city is to reduce global warming and to improve the quality of the air, water, soil, and land as a result. All citizens must have access to green and recreational space as part of the development of high-quality urban environments that are designed to meet the needs of all citizens. Thus, in order to be able to withstand extreme weather conditions as well as to preserve and regenerate endangered ecosystems and species, cities must adopt nature-based solutions that are based on green and blue infrastructure that can withstand extreme weather conditions. It is essential that green and blue areas are well-planned, well-managed, and well-connected if we are to preserve and develop the biodiversity of our cities.

In order for cities to be able to contribute to a diverse economy, as well as provide a stable financial base for urban development, they must be productive. The city needs not only affordable and accessible space but also skilled workers and technical, logistical, and social infrastructures so that production can be reintegrated into cities and urban areas. We can also encourage small-scale businesses, low-emission manufacturing, and urban agriculture can be encouraged, which will facilitate and promote the creation of mixed-use neighborhoods.

There are several ways in which a central urban area can be transformed into a multifunctional space where manufacturing, retailing, and services can coexist with housing, hospitality, and leisure, thus enhancing the city's development. Additionally, the New Leipzig Charter emphasizes the role of digitalization in sustainable urban development and identifies it as a powerful, cross-sectoral force that will significantly impact all aspects of the development of a sustainable urban community. There is no doubt that digital solutions have contributed to improving public and business services through the provision of innovative and high-quality services, but they can also increase spatial and social divides, as well as pose a threat to privacy. In order to implement digitalization in an environmentally friendly, inclusive, and equitable manner, it must be shaped sustainably.

In terms of implementing the document, there are four essential ingredients outlined in the document: (FG-SSC, 2015)

A) It is important to coordinate the development of urban areas through an integrated approach that takes into account all of the city's policies.

B) As part of a participatory process, economic actors, the general public, and other stakeholders must be asked to provide their knowledge, potential, and concerns, and this shall be done in order to enhance local democracy.

C) Using multilevel governance as a model for addressing complex urban challenges at local, regional, national, and global scales ensures that all social stakeholders are collaborating to address complex urban challenges on a local, regional, national, and global scale.

D) Place-based approaches have been proven to contribute to a place-based approach to the integration of horizontal and vertical coordination, evidence-based urban development, and endogenous urban transformation.

Having established the New Leipzig Charter after realizing that urban challenges existed during the early 1990s, it builds on previous European urban policies and programs, and policy documents. There were initiatives such as those in Germany such as 'Soziale Stadt,' which promotes social integration, and 'A New Deal for Communities, ' which promotes community life, and those in France such as 'Politique de la Ville' and those in Italy called 'Programmi di Riqualificazione Urbana.' Not only were these initiatives aimed at improving the built environment of cities, but they were also designed to increase social integration and urban cohesion. Additionally, the European Union has introduced special programs dedicated to urban regeneration in addition to these national responses. There are two direct action directions promoted in the Leipzig Charter of Sustainable Urban Development for 2007, which has gone far beyond its predecessor in advocating integrated urban development approaches and special attention being paid to deprived communities within cities. The Charter goes far beyond its predecessor and focuses on two specific areas that need special attention. Developed from the Amsterdam Pact (EU Ministers for Urban Matters 2016) (Williams, 2017) , the Leipzig Charter has been based on the objectives and achievements of the Amsterdam Pact and directly references the European Union's Urban Agenda and its upcoming multifaceted initiatives (European Commission 2019). There are three different perspectives from which social integration can be viewed, according to a 1994 report by the United Nations. Integration entails, as a first step, that every individual has the same level of opportunity and rights, and that is what inclusion is all about. Based on this vision, it is believed that a greater level of integration will increase the opportunities for everyone. Integrating has come to carry a negative connotation due to the negative connotations that have been attached to it. As a result of its implied connotation of forced uniformity, it has been associated with a negative connotation in the past. According to this view, integration consists of giving up one's identity to completely immerse oneself in the societal conditions of a given place while abandoning one's own identity. Finally, we should remember that integration should not be viewed as a moral construct but rather as a description of how human relations develop and are maintained within society rather than as a moral construct. This is because urban transformation is a topic that is most commonly studied by researchers in a variety of different fields, such as Urban Studies, Geography, Planning and Development, General Environmental Science, Ecological Modeling, and Economics. This topic involves various levels of research, which should be considered when conducting research.

This research examine in several aspects of urban transformation, such as the involvement of a range of actors, the involvement of society, the living laboratories, the resilience of the urban environment, technology, and factors that influence the transformation and resilience of urban environments such as the COVID-19 conference on resilience in urban environments. In addition to providing new insights into sustainable urban development, studies of smart cities can provide new insights into the social aspects of sustainability by highlighting the importance of improving urban carrying capacity, disaster resistance, and development capacity. The concept of social sustainability in urban contexts requires a more detailed interpretation, whereas the concept of sustainable development is defined as a transition between social, economic, and environmental aspects. In order to measure the social sustainability of a particular city or urban space, it can be helpful to look at its There are several detailed elements identified by (Dempsey et al., 2011) in the study, including social capital, community empowerment, citizen participation, social equity and justice, public infrastructure that benefits society, and access to services.

It is through social sustainability that a variety of factors contribute to the development of attractive urban spaces for living, visiting, studying, and working, as a result of a variety of social, non-physical, and physical factors. Having a safe, pleasant, and resilient environment that is conducive to a person's well-being is crucial to ensuring that people live happy, healthy, and fulfilling life. In today's socially aware planning process, a growing body of research has demonstrated that cooperation networks and "pro-community behavior" can be essential to fostering neighborhood safety and security as well as community well-being. There is a growing body of research that supports this point. In order to foster neighborhood safety and security as well as community well-being, a wide range of stakeholders are motivated to act and support one another.

4.1.1. Complex system

There are indeed instances where complexity is perceived as a unified framework for science and a revolution in the understanding of the human brain and the global economy, which has been difficult to predict and control due to their behavior. There is, however, a need to ask whether there is a complexity science or if there are branches of various sciences that deal with complex systems in multiple ways rather than a single complexity science. Because of this, the question arises: is complexity a single natural phenomenon that occurs in many different physical systems (including living systems) and can be analyzed by a single scientific theory? Or are examples of complex systems different from one another in ways that can sometimes have nothing in common at all? There is a fundamental question that has to be answered in the complexity sciences: What is complexity? In order to be more specific, it is pertinent to ask whether there is a universal complexity or if there is a domain-specific complexity when it is assumed that the concept of 'complexity' is not just a meaningless concept.

Complex systems and their features

Contrary to analytic philosophers of science, the social sciences and philosophers of social sciences have been relatively active in the discussion of complexity science in addition to those that have been discussed by analytic philosophers of science. The topic of "Complex Systems" was the focus of an issue of Science devoted to the topic as well as many of the key figures involved in the field. The issue featured many of the key figures involved in the field. In this study, a few lines of text from (James. L et. Al, 2012) is analyzed as an in-depth review of complex systems. In his analysis, he categorizes the definitions and the author's quote as follows:

1. "To us, complexity means that we have a structure with variations." (Goldenfeld & Kadanoff, 1999)

2. "In one characterization, a complex system is one whose evolution is very sensitive to initial conditions or too small perturbations, one in which the number of independent interacting components is large, or one in which there are multiple pathways by which the system can evolve. Analytical descriptions of such systems typically require nonlinear differential equations. A second characterization is more informal; that is, the system is "complicated" by some subjective judgment and is not amenable to a detailed description, analytical or otherwise." (Whitesides & Ismagilov, 1999)

3. "In a general sense, the adjective "complex" describes a system or component that by design or function or both is difficult to understand and verify. [...] complexity is determined by such factors as the number of components and the intricacy of the interfaces between them, the number and intricacy of conditional branches, the degree of nesting, and the types of data structures." (Weng et al., 1999)

4. "Complexity theory indicates that large populations of units can self-or-

ganize into aggregations that generate patterns, store information, and engage in collective decision-making." (Parrish & Edelstein-Keshet, 1999)

5. "Complexity in nature's landform patterns manifests two key characteristics. Natural patterns form from nonlinear processes, those that modify the properties of the environment in which they operate or that are strongly coupled. Natural patterns form in open systems, driven from equilibrium by exchanging energy, momentum, material, or information across their boundaries." (Werner, 1999)

6. "A complex system is one in which there are multiple interactions between many different components." (Rind, 1999)

7. "Common to all studies on complexity are systems with multiple elements adapting or reacting to the pattern these elements create." (Arthur, 1999)

8. "In recent years, the scientific community has coined the rubric 'complex system' to describe phenomena, structure, aggregates, organisms, or problems that share some common theme: (i) They are inherently complicated or intricate [...]; (ii) they are rarely entirely deterministic; (iii) mathematical models of the system are usually complex and involve non-linear, ill-posed, or chaotic behavior; (iv) the systems are predisposed to unexpected outcomes (so-called emergent behavior)." (Foote, 2007)

9. "Complexity starts when causality breaks down" (Williams, 2017)

In light of the last citation, it is evident that this is a challenging field. As many people have a permissive view of causality, there is no doubt that complex systems will have causal relationships. A large number of people believe that the primary focus of complexity science is to understand these phenomena. (1) is hardly informative if structure and variations have not been defined. There has been much discussion over whether complexity science should be conflated with chaos and nonlinear dynamics, whether complexity should have many components, or whether complexity should be conflated with a system with different possible histories. As far as the answer to our question is concerned, it is entirely subjective. (3) and (4) take us to more exciting territory. The concept of computation is the application of computational concepts such as data structures, conditional branches, and information processing to solve the problems of complexity science. (5) There is an introduction to the concept of nonlinearity. (6) and (7) indicate that a complex system comprises many components interacting with each other. There is too much confusion in (8) to make it worthwhile to describe a complex system in an informative way. Taking a cue from the quotations above and drawing upon the culture of complexity science as expressed through a variety of sources, including both popular and academic publications, here is a short list of the components as described by (James et al., 2012) :

"Nonlinearity, Feedback, Spontaneous order, Robustness and lack of central control, Emergence, Hierarchical organization, and Numerosity."

4.1.2. Urban Complexity

The concept of complexity in urban perception is based on taking into account social, cultural, and learning environments in order to determine the maximum rate of useful information. Future environmental research and design should be based on complexity and its achievement.

Evaluating Environmental Complexity. A general analytical tool for determining the relative complexity of existing and proposed environments has been proposed as part of the proposed definition of complexity. Although personal and cultural factors influence the perception of the urban scene, they can only modify the information the physical environment provides. Even though different aspects of the city may be fundamental to different people, the examples suggest that certain physical characteristics may cause complexity. Different cultures may share these characteristics, even if their local forms differ. Several questions remain unanswered, such as: how does the optimal amount of significant information vary among individuals and groups? For a given context and culture at a given speed, how many repetitions are required to establish expectancy? For a specific rule system, how much variation is needed? The fact remains, however, that it is possible to predict the relative complexity of the perceptual world by manipulating the physical components of the environment in a way that creates expectations and then violates them and by taking into account factors such as order regularities, speed of movement, and angle of view. Field and laboratory examinations are possible for these problems. It is necessary to validate both hypotheses experimentally. Simple panel experiments could test whether complexity is a desirable quality for urban environments. A panel of judges would rank a set of environments (presented through photographs, films, or models) on complexity, ambiguity, and preference. To test the first hypothesis, nonparametric tests of association would be necessary. It is far more difficult to test the second hypothesis, that complexity is a function of violated expectancies. In an urban environment, subjects could be asked to comment on a sequence of photographs or a film. Each time a photograph is shown, participants are asked to describe the scene and predict the next photograph with confidence. A measure of the strength of expectancies set up by the environment (P) would be the number and confidence in predictions. Based on the confidence with which predictions are made, this index can be compared with an index of violated expectancies (V). The environment may be monotonous or chaotic if V is low, that is, if few predictions are violated-both are due to a low rate of usable information. The value of P indicates whether the environment is monotonous or chaotic. Low P/high V is vacant because no more predictions can be violated than are made in a monotonous environment (high P). A chaotic environment will give weak predictions (low P). Complex systems can be seen in cities as paradigmatic examples. The city exchanges people, materials, and energy flows, as well as information, every day with the surrounding environment and with each other. A complex urban system is characterized by multiple 'feedforward and feedback loops' resulting from the interaction between socioeconomic factors and settlement structures at the city scale (De Rosa & Salvati, 2016; Frenken & Boschma, 2007). Depending on the population size and the economic dimension of each district composing the city, each city assumes an internal hierarchy. Furthermore, cities allow people to participate in a wide variety of human activities, such as business, recreation, and education, as well as serve as growth engines (Duranton & Puga, 2001; Ellerman, 2005; Thisse, 2018) . Innovating and entrepreneurship are major drivers of urban development (Ejermo, 2005; Florida, 2017; Markusen & Schrock, 2006; O'Donoghue & Townshend, 2005) . Research has proven that businesses prefer an environment that provides opportunities for growth and social interaction, as well as one that is diversified, highly competitive, and open to globalization. The urban vitality and local competitiveness of cities are positively influenced by land-use variety and social mix. City economic resources and actors are brought together to facilitate innovation and entrepreneurship (Duranton & Puga, 2001; Frenken & Boschma, 2007; Hill & Brennan, 2000; Rosenthal & Strange, 2001). A diverse socioeconomic function occurs in urban systems as a result of heterogeneous economic structures, a heterogeneous employment pattern, and a heterogeneous socio-spatial structure (Viladecans-Marsal, 2004; Ottaviano & Peri, 2006; Grant & Perrott, 2009; Kroll & Kabisch, 2012). The following studies were conducted (Burger & Meijers, 2012; Davies & Donoghue, 1993; O'Donoghue & Townshend, 2005). While subcentral locations are becoming more specialized, urban regions are consolidating new growth poles. Both endogenous and exogenous factors alter the socioeconomic structure of metropolitan regions, resulting in a mix of land-uses and related variability that are critical to urban complexity (Jacobs, 1969). In order to identify and characterize the latent interactions between socio-spatial and economic structures that shape metropolitan complexity, it is necessary to identify and characterize the spatial proximity among different land uses and the potential for social interaction and economic benefits, (Salvati & Serra, 2016) Urban transformation is characterized by territorial patterns, cultural and political processes. The highest levels of morphological and functional diversification, reflecting a variety of planning practices, can be found in core cities with high economic functions and stratified social structures. In addition to street patterns and land-use diversity, one characteristic of urban quality is building and space attributes (Montgomery, 1998). Taking into account the characteristics of central and sub-central locations, demographic size, and economic power, along with their socioeconomic relationship, as the spatial shaping dimensions of urban complexity, the same theory applies to larger spatial scales, with diversity being one of the most common concepts applicable to areas that include one or more growth poles. In addition to providing insight into the fundamental challenges of recent urbanization processes, a comprehensive analysis of diversified metropolitan structures has been shown to reveal the spatial ties to urban complexity that underlie both processes. According to Jacob's externalities, related variation within economic sectors was effectively measured using entropy measures. Inequality and class segregation could increase due to unrelated variety dampening unemployment growth. Employment growth is enhanced by Jacob's externalities, while unemployment growth is dampened by unrelated variety.

Also commonly used in city studies for class segregation, social diversity, deviance, and crime are the diversity and entropy indices. As local socio-economic functions become more complex, attributes such as land use diversity, building age, and land imperviousness have been increasingly viewed as indicators of urban centrality. (Della Torre et al., 2014) evaluated soil sealing heterogeneity using entropy-based functions for representative regions in Europe. Based on Salavati and colleagues' (Salvati & Serra, 2016) demonstration, such a function is superior to others empirical approaches Pielou's evenness index (Heip, 1974), It offers a reflection on urban diversity in accordance with (Jacobs's 1969) thinking by examining the unique bond between form and function in each city, as well as an operational approach to assessing metropolitan complexity. Metropolis complexes are characterized by the interplay between form and function in each city, which integrates social, economic, and territorial diversity into one unique concept. By demonstrating how bottom-up processes interact with new forms of geometry and spatial relationships, (Manson & O'Sullivan, 2006) provide advanced knowledge of highly complex systems.

A complexity theory may provide a more comprehensive perspective on urban dynamics due to its structural similarities with social philosophy theories (Portugali, 2006). Complexity theory has many (positive) implications for urban performance and resilience as it has become more common to analyze cities through the lens of complex systems (Boeing, 2018). Several academic studies have demonstrated that metrics at multiple scales can be used to analyze the relationship between adaptive complexity and diversification that results from urban dynamics (Salvati & Serra, 2016). It is challenging to measure the complexity of cities. Various dimensions can be used to categorize urban complexity indicators, according to (Boeing 2018). Therefore, they capture measures related to temporal, visual, spatial, scalability, and connectivity. Considering that urban diversification is a tool to provide an informed basis for policies to promote resilient metropolitan systems and sustainable paths of regional development (Cuadrado-Ciuraneta & Antoni, 2018; Di Feliciantonio & Salvati, 2015; Duvernoy et al., 2018) , it seems especially relevant to analyze urban diversification as a tool promoting resilient metropolitan systems and sustainable paths of regional development. In line with mentioned background on urban complexity, A multi-domain analysis of 12 indicators assessing social, economic, as well as territorial dimensions of urban spatial complexity, was performed in order to produce a composite index of urban spatial complexity. A proposed index is based on the morphology of local contexts in order to delineate divergent development paths based on the relationships between the morphology and the function (apparent and latent) that exist between them (Ejermo, 2005; Ellerman, 2005; Frenken & Boschma, 2007) . The indicators we use in this study are aligned with the documents mentioned above. However, we propose a network-based, data-driven approach to evaluate instead of relying on a one-size-fits-all approach. This subchapter presents a literature review highlighting a relatively well-cited background for conceptualizing an urban setting as a complex system.

4.1.3. Big Data for urban management

As urban and regional analyses cover a variety of sectors, such as transportation, the environment, health, housing, the built environment, and the economy, they use a variety of methods to understand and manage them. Research on urban issues includes analyzing the impacts of urban policies on infrastructure, physical systems, and socioeconomic systems, as well as understanding how to improve urban operations and management. A study of infrastructure, physical systems, and socioeconomic systems is included in this category. The United Nations estimates 54 percent of the world's population lives in urban areas as of 2014. This places significant demands on resources and makes urban management a major concern around the world. In order to operate cities efficiently and effectively, decision-makers must address several questions, such as what strategies are needed? Complex social policy changes can have what kind of consequences? What are the ways in which we can make cities shockproof, and what are the ways in which we can make the economy resilient and strong? Different cities respond differently to natural or artificial disasters. What are the technological, social, and policy mechanisms needed for developing interventions for healthy and sustainable behaviors? What strategies are needed to promote lifelong learning, civic engagement, community participation, and innovation? Using historical examples, how can we generate hypotheses about the role of agents, policies, and practices in social exclusion? The Big Data tsunami has affected urban research as well as many other disciplines. It has therefore become an important resource for practitioners and decision-makers looking for solutions to governance, planning, and operations across multiple urban sectors. For resource management, knowledge discovery, civic engagement, and policy analysis, urban systems are explored and understood in urban informatics. Urban Informatics research emphasizes both a theoretical and empirical perspective. Innovations in technology, institutions, social systems, and businesses are creating new sources of such data, providing urban researchers with new opportunities. A key aspect of data integration is the ability to access and link hard-to-access data sources, enabling new connected data systems.

A major research question in Urban Informatics can be investigated using Big Data, as well as existing research questions that can be revisited with better data. Technical challenges related to managing the data and addressing methodological and measurement questions are equally important to the main agenda of knowledge discovery and a better understanding of urban systems. A huge epistemological challenge facing urban informatics is its use of Big Data to conduct research, establish institutions, and understand the economies of cities. Several disciplines and communities use it differently, which contributes to its ambiguity. Having numerous concepts associated with this topic further intensifies the ambiguity. Big Data: Complexities and Types Despite the potential benefits of the topic, the vagueness and well-worn clichés surrounding it have undermined its use cases. Four groups of definitions were derived from an analysis of 1437 conference papers and articles with the whole term "Big Data" either in the title or as some kind of keyword.

The following are the definitions:

1) Aspects of Big Data include the sheer amount of data that they contain, its rapid growth, complexity, unstructured nature, and so on, where Volume', Variety', and Velocity' refer to the sheer amount of information they contain, and the challenges they present (Laney 2001) (Diebold, 2012). Scalability architectures for storing, manipulating, and analyzing large amounts of information;

2) the technical requirements behind the processing of large amounts of data (e.g., serious computing power);

3) as a form of data whose processing capacity exceeds that of conventional database systems (e.g., Big Data);

4) As highlighting the impact of Big Data advancements on society (e.g., changes in the way we analyze and organize information).

Further, the term Big Data is not just about data; it refers to a curiosity and goal-oriented approach to extracting information from it (McAfee et al., 2012), focusing on automating the entire scientific process (Pietsch, 2013), including data collection, processing, and modeling. As a result of Big Data's close association with data science, which emphasizes data-driven modeling, hypothesis generation, and visual data presentation, this is partly explained. This is an element of the Fourth Paradigm of Scientific Discovery (Gray et al., 2015), according to researchers who focus on exploratory, data-intensive research contrast with earlier researchers who wrote descriptions, developed theories, and simulated observed phenomena computationally. Censuses, surveys, and specialized sensor systems have historically been used in quantitative urban research. However, declining response rates to traditional surveys, increasing costs associated with administering the decennial census, and maintaining and replacing sensor systems have led to significant challenges in obtaining high-quality data for urban planning, research, and operations, even though these data sources will continue to play a significant role in urban analysis. There has been an increase in interest in looking at alternative ways to supplement the urban data infrastructure due to these challenges. Big Data refers to structured and unstructured data produced naturally from transactional, operational, planning, and social activities or the linking of such data with purposefully designed data. It presents technological and methodological challenges and complexities regarding the scientific paradigm and political economy supporting inquiry using such data. While there are many ways to organize Big Data for urban research and applications, this grouping is primarily informed by the user community typically associated with each type of data; we also take into account methods of generating the data, as well as issues of ownership and access. Sensor systems are not mutually exclusive; for example, public agencies may own them for administrative and operational purposes, as well as private companies for transactional purposes. The government collects micro-data on citizens during everyday processes such as registrations, transactions, and record keeping. Tax and revenue agencies keep records of citizens' taxes paid, revenues generated, licenses issued, and real estate or vehicle transactions.

Employment and benefits agencies collect information about income, earnings, disability benefits, and retirement benefits. Urban policy evaluation can benefit greatly from administrative microdata. In addition to being relatively inexpensive and potentially less intrusive, administrative data have the advantage of being comprehensive and yet relatively cheap. The data source also has a larger sample size, fewer issues with attrition, non-response, and measurement errors (Card et al., 2010). Open data initiatives are making administrative data more accessible. This type of initiative is frequently driven by open government strategies, which are generally considered transparent, collaborative, and innovative. Nevertheless, there is some confusion about what these terms mean in practice (Fung et al., 2013). The open data movement believes government data should be available for everyone to use and republish without restriction in order to develop a more informed, engaged, creative citizenry and improve accountability and transparency.

The use of open data can lead to innovations and address the needs of the disadvantaged (Thorhildur et al., 2013) . National and local governments around the world now support open data policies. In order to address this issue, Government agencies have incorporated open data portals into their websites that allow aggregation or anonymization of administrative data, free from license restrictions. It is indeed the case that open data initiatives are offering a lot of benefits, but they can also be challenged by a variety of factors, including closed government cultures in some areas: privacy legislation, limitations in data quality that prevent publication, and limitations in user-friendliness. It is often the case that administrative data requires access to personal information at the level of individuals, such as microdata, which is usually protected by the law regarding personal data protection. The benefits of having access to and sharing identifiable administrative data for research purposes must be balanced with the requirement for data security to ensure that the personal information of individuals is protected. Information that identifies an individual can be used individually or in conjunction with other information. The use of confidential administrative microdata by urban social scientists with interests in economics, public health, and medicine is of great interest. Several current activities involving confidential data may be of interest to urban researchers. Four large administrative data research centers have been funded by the UK Economic and Social Research Council to provide confidential administrative data linking services, similar to those offered in Denmark, Finland, Norway, and Sweden. It combines data from federal, state, and Census Bureau sources about employers and employees. The Longitudinal Employment Household Dynamics (LEHD) program is an example of a nationwide initiative. (Abowd et al., 2005), detailed estimates of labor market and workforce dynamics are produced by combining unemployment insurance records, wage, and employment data, administrative and census data. A person's administrative data can sometimes be linked longitudinally as well as between registers of various types. For example, parents' employment information can be linked to a child's test scores, or medical records can be linked to information about the individual's historical location. For instance, researchers could investigate epigenetics and disease heritability through the latter (Aguilera & Jackson, 2010) . Through these links, we can examine variations in health and social exclusion across space and time.

5. Conclusion

There can be no doubt that the study of urban areas and the connections between the urban elements and the cities in order to establish a regional, national or international space is an integral part of the evolutionary perspective on transition if we consider the urban elements as part of the urban elements themselves. In terms of transition, it may be viewed as a steppingstone toward developing human society's new living environment based on the use of social, economic, and environmental infrastructure. The environment might be a physical one, a virtual one, or one that is evolving into something new. The purpose of this chapter is to describe how humans are adapting to urban changes by taking a multidisciplinary approach in order to do so. This thesis takes the position that humans owe their identity to the continuous transition they have experienced during their lifetime on this planet, which is why we are expressing how humans cope with the changing urban environments in which they live. This was done using mathematics as a tool to understand how these relationships work in order to gain a better understanding of them. The purpose of this chapter is to introduce a tool that can be used to analyze social networks. In subsequent chapters, we will examine in detail what will be inside this tool, using case studies to illustrate each mathematical element and calculation involved in the analysis of social networks in detail. In order to create meaningful economic clusters in urban and regional areas, we will use this tool and B-data to identify and explain how and why these clusters are related. Throughout this chapter, the author discusses the mental framework he used in dealing with the transition process and how these concepts were tested in Italy and the United States as part of his experiment.

6. Chapter 1 scientific publication

Introduction

After introducing principal concepts in urban planning and urban regeneration in areas such as resilience and managing urban transformation, there is a need to introduce a suitable theoretical concept. This concept should be practical to synchronize between what is stated in chapter one of this research and the rest of the chapters to achieve an element to guide our guiding path. In other words, at the end of chapter one, after specifying how the transition process in different theoretical aspects can be measured and described, like the evolutionary economy and economic transition. Moreover, after introducing the direct relationship between the evolutionary economy and a complex system like an urban system and introducing an identity as resilience for the relationship between transition and urban space. The researcher should be able to put his thoughts into practice. As so, a research paper on how to make and assess a complex system using network analysis is introduced. What is explained is the way to form urban phenomena in mathematical algorithms. This explanation will not only help in calculating and forming an urban economy but also help in putting random phenomena in the form of the evolutionary process and later use innovation as a driving force to show the interwoven relationship between different layers of a city as it was argued how it is possible to know a city as a complex system. The following paper describes how a city became known as a complex system and how programming periods in the European Union, trans-Atlantic, and even eastern city planning could affect policymakers' understanding of introducing the locality view for urban planning and urban economy. Furthermore, the essay describes a historical review of theories regarding urban transition. Finally, it introduces a place-sensitive concept as a unique identity for a city that follows post-modern scholars.
The researcher analyses how a place can have a space, holds a human in it, records all the interactions the human has, and uses these interactions as a proxy for the relationship between different places. During chapter one, it was stated numerously that connection and interwovenness are, in fact, the main elements in making a dynamic network that has evolved. What we describe here as the ideas of the trend project research team is giving form to this interconnectedness. Then we introduce a scaling tool and then observe the incidental connections. Finally, we introduce this relationship by conceptualizing points, lines, networks, and tools for understanding a network. The contribution of this essay is introducing practical and theoretical elements to analyze them better, which are described in detail in chapter two. Furthermore, this essay is the first step to describing a tool for introduction analyzing and illustration from the conceptual frameworks of the researcher, which is described in detail in the following chapters. Informational."

Networking analysis in the urban context: Novel instrument for managing the urban transition

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Abstract

Nowadays, the insurgence of shocks in every dimension of life is questioning the effect of globalization on the urbanization process. The exposition to risks, related to the impact of continuous environmental and economic shocks, seems, in turn, increasingly connected to high urbanization processes. Among a variety of specific vulnerability factors that can influence the life of the population in each settlement, two sources of them seem to be generalized: Higher levels of income inequality spread in urban areas, the concentration of knowledge complexity in large cities. Traditional urbanization theory has become hard to interpret these changes on a global scale, and "innovation" is a core concept to explain the new differences in the urbanization dynamics.

The paper aims to combine urban and innovation policy towards the post-Europe 2020 Strategy, as a scientific advance in urban and regional studies within innovation policy design. It is argued that this combination is a crucial need due to the pivotal role that the city is acquiring in managing adaptation to shocks and in designing new approaches in line with the Just Transition mechanism introduced by the European Union.

The paper argues that in light of a completely new scenario of development, especially after the pandemic, due to the necessity to make a transition towards sustainability, the traditional approach of analyzing the context to drive the political choices of transition need to change. Data analytics is acquiring importance in the decision making that required to be faster due to the continuous and unpredictable shocks are facing us. The technological progress, the engine of development is crucial in driving cities and territories towards a transition to a post-carbon economy.

Since the city transition is not formal top-down management, the network modeling of this structure and the complexity of the component would be an exciting approach. Network analysis, both as a tool to measure the change and as a new framework for urban management, could play an essential role for policymakers to develop a responsive dashboard that benefits from local data to generate place sensitive materials for decisions. The urban system is consistently facing turbulence which leads politicians to convert them to a path to analysis, this point of translating the routine tensions into the challenges following a pattern of emergence and remedies to a cure

are resilience building. Defining urban resilience in city level is double-sided sward however it grasps the prosperity of the innovation tightly, but would stem educational shields for fresh ideas required incubators to grow.

The expected result is to explain how applying the networking analysis at the urban level can change the perspective of urban planning, create an Ex-ante mechanism based on network modeling for policymakers to foresight trajectories based on their decision could depict an utterly novel approach in urban management tools.

Parole Chiave/Keyword: urban_transition, nnovation_network, place_sensetive, technological_resilience

Introduction

Brief history of urban transition

Due tothe European commission council, the aim of applying cohesion policies, is tolead the regions as a whole in the transition pathway (Armondi, 2020) (Urban agenda), this goal acknowledging that the green, digital and demographic transitions affect different people in different ways, equal opportunities, and jobs for all means empowering people through quality education, training, andskills (Bulkeley & Betsill, 2005). However, the regional scale isessential, but the local one is more tangible, the current phenomena of urbanization tend the transition more in an urban manner which translate thetransition management for a term of "Managing Urban Transition" in short it isvital to explore the concept based on urban context and investigate theconnections and dynamics on this boundary. Much of novel consideration of European horizon, planning is built from the starting point of the set of applications on the region to develop more comprehensive development path called smart specialization. Smart specialization is the capacity of areas to implement structural changes in their economies throughthe "Entrepreneurial discovery process (EDP)" as an opportunities and the concentration of resources in those fields (Fuster Marti et al., 2020). These series of policy-making stimulates the process in a non-neutral logic favoring selected new activities employing concentrating resources to those that are anticipated to transform existing economic structures. Proposed policies range from public venture capital and entrepreneurship development programs to those which support the improvement of human capital conditions, R&D competencies, and the region's embeddedness in interregional research networks. Typically, modern cities spread over broad areas. Spatially speaking, sustainability research and policy-making should shift focus from city centers to urban regions and global networks of production, consumption and distribution (Wachsmuth et al., 2016). The urban system is consistently facingthe shocks and stress which inflected by economic, social and environmental dynamics forcing the policymakers to convert them at the path to investigate and to encounter, this point of translating the every day tensions into the challenges following a pattern of emergence and remedies to cure are resilience building. However, this process is often costly and risky. Still, the big mass developing by the implementation of the action plans is crucial; the outcome is a system by itself called "urban resilience." Urban resilience has many definitions,most of which take into account the ability to manage the full range of shocksand stresses which may occur in a city (Meerow et al., 2016). Notably, resilience refers to the ability of a system to maintain or quickly return to desired functionality following a disruptive event (either natural orhuman-induced), which may not be predictable. It incorporates the ability to avoid shocks and to manage risks while being able to adapt to change when needed and continually quickly transforming systems that inhibit current or future adaptive capacity. Synergies and tradeoffs must also be considered to identify Investing in resilience contributes to long-term sustainability by ensuringcurrent development gains are safeguarded for future generations. As aforementioned, We donot yet know how challenging it is to decentralizing the transition with smaller-scale distributed systems (urban level). However, smart cities and smart communities are popularly experimented with (Coffee et al., 2010) andmay eventually lead to useful conclusions, but that time is still somewhere inthe future. This article is forming the transformation structure into a mixedscenario of qualitative evaluation in the quantitative monitoring approach, which intended to suggest a new perspective for Managing Urban Transition.

problem statement

Place Sensetive- Context driven approach

Thethe paper argues that in light of a completely new scenario of development, especially after the pandemic, due to the necessity to make a transition towards sustainability, the traditional approach of analyzing the context to drive the political choices of transformation need to change. In this extent, nowadays the insurgence of shocks in every dimension of life is questioning the effect of globalization on the urbanization process. In one hand with the Industrial Revolution, the primary source of wealth moved from the countryside into the city (Cusinato, 2016) in another hand exposition to risks, related to the impact of continuous environmental and economic shocks, seems, in turn, increasingly connected tohigh urbanization processes. Among a variety of specific vulnerability factors that can influence the life of the population in each settlement, two sources of them seem to be generalized: Higher levels of income inequalitychniques of converting information to the wealth called "Technological resilience" new factor to influence urban context defining an empirical patternfor technological readiness by examining the degree of relatedness to exploittechnical flexibility is the crucial factor to demonstrate whether longterm vulnerability factors (VF) are measurable. It is important tomention investigating the effect of the possibility to enter a technological crisis (as VF) in deferent levels of technical flexibility exhibit the negative coefficient which defines open network pattern for knowledge defusion, at the same time the intensity of shock caused by the two challenges as mentioned above shows there is a significant negative effect of the flexibility of urban knowledge structures on crisis intensity (Karam, 2017), it is essential to mention, this new variable is not only based on the economic structure of a spatial unit but more comprehensive view demonstrate that the specific patternof an area, both social and environmental axis is essential, in this manner, the coefficient more "place sensitive" than an empirical one-size only equalization to deal with. Place a sensitive approach, recognizing that the criteria for future priorities will be context-specific for any given the solution. The point is any urban settlements can be tested to determine their likely long-term ability to continue and deliver their function– that is their resilience to achieve the ultimate goals of transition. However, those mentioned factors are the most critical area of intervention. Still, the dynamic of the challenges into dens, interconnected, and the fast-changing system is an inevitable issue by itself, which required a new perspective to encounter. To be more prepared for the current urban transition toward future goal foresight for sustainable pathways towards livable, affordable, and prospering cities in a world context.

Objective

Innovation Policy (re)design

The paper aims to combine urbanand innovation policy towards the post-Europe 2020 Strategy (Luyckx et al., 2021) (Sustainable development goals), as a scientific advance in urban and regional studies within innovation policy design. It is argued that this the combination is a crucial need due to the pivotal role that the city is acquiring in managing adaptation to shocks and in designing new approaches in line with the Just Transition mechanism introduced by the European Union.According to this objective,the methodological approach of the research is formed on the fact since the city transition is not formal top-down management (Mosannenzadeh & Vettorato, 2014; Pissourios, 2014; FG-SSC, 2015), the network modeling of this structure and the complexity of the component would be an exciting approach. Network analysis, both as a tool to measure the change and as a new framework for urban management could play an essential role for policymakers to develop a responsive dashboard that benefits from local data to generate place sensitive materials for decisions. Formal urban management rarely address the socio-economicnexus directly except to assume that continuing affordable economic requirement to each aspect will be assured without any particular additional measure. Because of this path dependency, it can be said that the assessment tools, models, and policy recommendations of many planners seldom build on the nexus of risks and solutions. Conventional planning, design, and governance systems struggle to meet the supreme position that cities have taken, namely as the most prosperous places in the modern world. To avoid making the same mistake, considering the city as the dynamic Network is essential then for next step necessary to understand the networking a tool as a monitoring and evaluation system can investigate the context both in micro and macro level the latter functions depend on the maturity of the Network and its scale. It is vital to (re)definethe terms in Network Theory to form the hypothesis and reasoning; thus we start with a short glossary of the definition and vocabularies. Then we will continueon the basics of the network connectivity, clustering, analysis, and resistance as the attributes of the system. It is important to notice "Network analysis" would not solely unilaterally examining the data, but the multilateral nature of the change (Transition) and system adopting phases (Resilience) regarding time intervals and correlations will be taking into consideration. Then to (re)structure the hypothesis the methodology derived from graph theory, attemptsto describe the assemble the relations (displayed by links) between given observing (displayed by nodes), and applies quantitative techniques to produce relevant indicators and results for studying the characteristics of a whole Network and the position of individuals in the network structure.

Glossary of Network analysis

Node

In the specific definition of network analysis in urban management, nodes are the multi-scale boundary of stakeholders or even spatial units dominated to particular functions. These properties are zoomable and trans-dimensional, which providing an opportunity to investigate the micro and macro levels of interaction. However, the methodology for defining the nodes is essential, but the most vital point of analyzing the nodes is addressing them into the network. One of the main applications of network analysis is the identification of the "important." nodes in their network (Wasserman et al., 1994) . The idea of the centrality of individuals in their system is one of the earliest to be pursued by network analysts (Borgatti et al., 2009) . It is used to acquire the positional features of individual nodes within networks. (Freeman, 2004) identified three forms of centrality. It is the most intuitive property of a node. The second measure of node centrality, closeness, is based on distance or proximity. The action focuses on how close a node is to all the other nodes in the set of nodes (19). The degree of closeness is not only based on the nodes and the neighbors but also demonstrates the degree of relatedness in the network. In data analytics literature, we translate nodes as the unit of data production, the observation box that carries unique coordination into the data pool.

Edge

Edges are representing the connection in classic literature for graph theory and network analysis this the link is either tangible or in a conceptual level known as possible connectivity. However, in this article, we are introducing a novel perspective to all these definitions but playing a role in same grounds for all the connected nodes is a must draw a link. We do not yet know a robust protocol for proving a potential connection but the importance of bilateral transaction between nodes is considered a direct transmitting path for the proposed network. In term of innovation network, number of patents traditionally considered as quantitative indicator for the depth of knowledge and innovation creation instead of in our the proposal this quantity would demonstrate the ground for interaction between the nodes, for example, the higher number of patents in a node shows the more intensity of connection between intra-node dimensional contacts. Researchers in IT and data science disciplines do not consider all the links at the same level, Convolutional Networks, for instance, demonstrate the multi-level connections between two or more nodes in three dimensions. An artificial neural network is another example for interdisciplinary investigation on urban management and data science which translating the urban reciprocity into the term of collection of connected units or nodes called artificial neurons.

Degree of connection (two edged)

In much transitional literature, knowledge is assumed to be a public good: once discovered and publicized, it is freely available to all in the context. The diffusion of information is a process embedded in location. Distance is essential in knowledge diffusion — the closer we are to the area of the originator of knowledge, the sooner we acknowledge the benefits of innovation network (Tang et al., 2009) . Looked at diffusion over a geographical distance; (Salvati & Serra, 2016) adds social distance. Knowledge diffusion is not only a geographically spatial phenomenon, but it is also a "socially spatial" phenomenon. That is, the more closely connected socially, in other words, suggest is that knowledge diffusion is taking place to a considerable extent by personal contact. Space matters for knowledge diffusion and social space may matter as much as or more than geographic space. "Social space" can only be sensibly understood in the context of social networks. It is mainly the case in the context of innovation when the transmission of knowledge plays such an important role. Another side of this network formation is the class of knowledge, and the level of sedimentation for particular property transacted between and inside the nodes. For instance, codified knowledge can be diffused globally, without reference to underlying connection structures, but tacit knowledge has very different properties. Its diffusion depends heavily on the network of agents through which it will spread. The central idea is that the "Urban system" takes advantage of a large amount of autonomy between nodes, but at the same time uses links between those nodes to transmit value between them. This sounds much like the suggested description of an innovation network for a potential urban context where agents (despite the socioeconomic classifications) are nodes, they are linked to particular other nodes, and interconnection takes place only over these (re)direct links. Social capital, developed by direct interactions between agents; in this proposed network is innovation, permit the agents to circumvent many of the problems implicit in anonymous markets such as opportunistic behavior, imperfect information, and incomplete contracts, the transmission of tacit knowledge, knowledge spillovers and so on. The social capital developed through network interaction, therefore, reduces transaction costs and can serve to make the node more efficient in many ways. This is a more profound understanding of new urban resilience in the innovation era, Technological Resilience, which leads the nodes to optimize the connection by economic filters to maximize the competitiveness and to cut back the transmission to prevent any unsought knowledge spillover.

Classification, Clustering and associationz

Due to the context of this paper we do not explain classic network formations (Ising, Marshall's and etc.) instead of the interaction between the transitional property and the connection building progress is taking into account. The main objective of this section of the research is the target, defining the aim of contact and describing the best scenario for interactions between the nodes includes three different layers, first, to investigate Why the nodes are connected? following this path the identity of each coupling is interconnected, the transaction has its own identity as well and agglomeration of those same ground, same target transactions form a "classification." As an example, in Urban context, all industries, research centers and privet/public stakeholders who are connecting each other for a project (contest) are considering as n number of coupling interconnected nodes, then the m number of transactions despite the positive or negative result demonstrating the coordination (n,m) of a the single multilevel node in the innovation as mentioned above matrix.

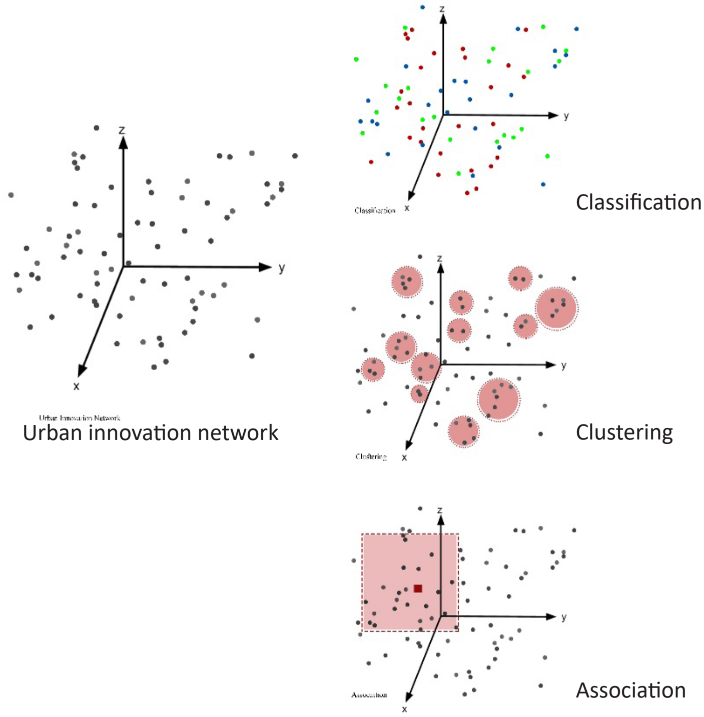

Figure 1 Classification, Clustering and Association

Another concept in this field is based on the maximizing the differential variance of the nodes in context and, at the same time, minimizing the difference of similarity. More in details, the interconnection between the nodes would not necessarily follow the same target but the proximity both in term of the spatial unit or knowledge creation codification is the clustering element. To form these structures among the nodes an ex-ante consideration of target is a must, and the evaluation is An N-folded scenario in which there is no fix coordination of coupling in transaction matrix. An important property for connections are the probability of co-occurring the transaction between n nodes, in this element, there is no coupling scenario to investing instead of being in the same ground and acting at the same level despite quantity or target considered group of convergence association; on of possible translation for this categorizing into our research context is performing for or against a the challenge in an urban system required a series of interactions between actors, in this system, there are numbers of classification which are classically dominated to the target of this rescue mission, in another level the geographical proximity to the hot spot form clustering dimension between infusers of the risk, but there is always a third layer which doing transactions neither directly connected to the target nor geographically close to the spatial unit but perform most appropriately and impact the result.

Networking Coefficient

After defining interconnections properties for the proposed innovation network, it is essential to investigate intra-connection the factor for it, it seems there is a meaningful relationship between the constraints of transmission, number of nodes and connection in one hand and the ability of classification of the network in another, which we suggest to call it Networking coefficient. This coefficient forms the network from a multiplex perspective. This structure has its unique dynamic, in which each period one transaction is chosen due to the mentioned coefficient. At urban context, it selects one of its interaction, and with that level of probability makes all possible trades. Over time, the node's knowledge endowments change as they trade. Possibility to expand the network is another function which following this coefficient, absorbing knowledge and developing new transaction by brand-new nodes assist data collection phase in elaborating evaluation more in detail. This diversification session has been one of the fundamental causes of arrangement growth. Besides, because an expanding innovative transaction base demands an expanding knowledge base, this Multiplicity has been a leading cause not only of an increase in R&D sectors but also of an increase in external technology sourcing (Breschi et al., 2003).z

Data analytics in network analysis

Data analytics is acquiring importance in the decision making that required to be faster due to the continuous and unpredictable shocks are facing us. The technological progress, the engine of development is crucial in driving cities and territories towards a transition to a post-carbon economy. As mentioned before considering the city as a the network of interactions and the spatial units as possible nodes the data transmission between the actors is the key factor to monitor, evaluate and control the transition. In this section, we will suggest combining one of the standard data science methodology (CRISP-DM) with urban management to initiate transition dashboard for policy-makers, the CRISP-DM method is described in terms of a hierarchical process model, consisting of sets of tasks related at four levels of abstraction (from general to specific): phase, generic job, the specialized task, and process instance (25).

Converting this to urban transition management generates a novel framework for mapping city transformation based on data pool creation. At the top level, the data mapping process is organized into several phases; each phase consists of several second-level generic tasks. This second level is called generic because it is intended to be general enough to cover all possible data gathering situations. As aforementioned improving the ability to collect complete and stable data has close relation with predication and dynamic explanatory model generation. (Directorate-General for Research and Innovation (European Commission), 2018) Complete means are covering both the whole process of transactions and all possible data for interaction. Stable means that the model should be valid for yet unforeseen developments like new modeling techniques. Ata third level, which we call it cleaning data to achieve a total specific solution, in this phase research team should consider all possible investigation target(s)and act in the most optimized way. In practice, many of the tasks can be performed in a different order, and it will often be necessary to backtrack to previous assignments and repeat specific actions repeatedly. At the final level converting data to information and then the decision is expected.

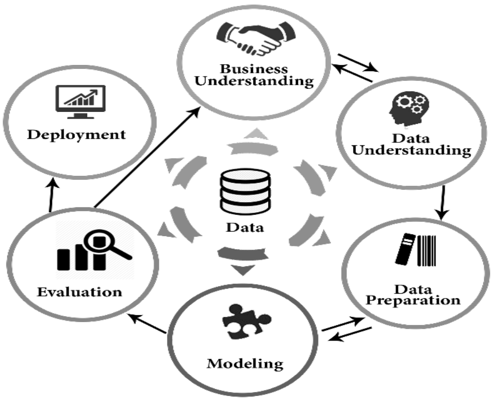

Figure 2 CRISP DM modeling

It is needless to say that all this methodology established on an EX-Ante regulation; thus, every possible information necessarily follows the expected prognostication requirements.You can see the cyclical nature process in figure 2, in which despite trade-offs between action boxes inside the reference model the whole exercise should review dependent on the updated the objective of policy (re)design.

Conclusion

In this paper the expected result was to explain how applying the networking analysis at the urban level can change the perspective of urban planning, create an Ex-ante mechanism based on network modelling for policymakers to foresight trajectories based on their decision could depict an utterly novel approach in urban management tools. As previously described this tool is founded by data piling as fuel for the innovation engine to run the transition, these cascade of cause and effect give on to authors for enriching unusual experinces in combination of data sience, applied math and urban managment. At this stage there are lots to do to profound the instroment as trustworthy tool for investigation moreover among all rhetorical question "How aggregate knowledge levels grow with these underlying urban data nexuses?" is one of the open questions in front of research team.

One crucial discussion this short research analysis pointed to is to review a comparative literature review to pave the way for data science and urban regeneration collaboration. We suggested a study method that can be described as a model of reasoning that relied on big data pilling and algorithm building. The method has a unique data gathering strategy, analysis, and reasoning. Network visualization has been introduced as the illustration and calculation method at the same time. While the graph theory support connections in the "No dimensional" spaces and the city places are the spaces with the functions assigned by the human thus, we believe the network studies is a relevant algorithm for collaborating with the urban regeneration goals. The urban area, as a complex system of interactions, is evolving in this way. We believe a model that can evolve and pinpoint the most relevant agent or connection in real-time scenarios is highly demanded.

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Chapter 2

Transition with Resilience in Urban context

Abstract

A new method of interdisciplinary perspective on a global phenomenon requires a novel tool, and then we are introducing it. Network, as its general meaning, is a concept of connection, agent, and fellow. All ingredients for a complex system illustration. This chapter is a continuation of the previous chapter's ideas on Big data, Urban transition, and resilience. To allocate a form to the concept, we are working with network modeling and graph theory; however, both remind us that a network is a system that will graph its methodology. Then we explore innovation as a flowing matter in the network which generates wealth and prosperity. This system works well if the context reflects the outcomes. Thus we are evaluating a case study (Calabria region) at this stage and demonstrate the region's potential at the local level. After testing all of the ideas in this step, we introduce endosymbiosis as a biological theory for living species, as the city is alive. Cities are alive because of evolution, energy conception, reproduction, and many more common factors. In order to address this in our research, we utilize state-of-the-art biological theory to explain living networks into each other., it becomes the setting for an experiential and apocalyptic vision of a daily routine, with rules and restrictions. The impossibility of going out, the proxemic enclosure of a current lockdown, manifests itself in the vertical connections, ladders of knives, the analogies with a confined public existence.

Introduction of chapter 2

1. Introduction

In this chapter, we are going to introduce a new perspective called the network, as well as the tools we can use to develop solutions to the issues that have been addressed in the previous chapter. As a result of network theory, we are going to introduce a number of tools that can be derived from it. As some of these tools can be used, there are some that can be used to visualize the information, the use as graphs, calculations, the use of network statistics, conceptual frameworks, the use of economic networks, and cluster analysis. In a way, they can all be viewed as the definitions of network theory in a sense. As part of our introduction to nested networks, we will also introduce the concept of nested networks. It has been mentioned already that nested networks are a representation of how human life is layered down into various layers. Physical layer, the environment in which a human lives, the economic layer, the management layer, and the social layer are some of these layers. We will discuss biological endosymbiosis in the following sections in a metaphorical manner as a means of illustrating the process. A sort of relationship in which one organism lives within another is called endosymbiosis. The mitochondria and chloroplasts of a eukaryotic cell were formed when a prokaryotic cell internalized a chloroplast from another eukaryotic cell. There are two membranes that surround the chloroplasts and mitochondria of the cell. There is a bacterial ancestor that provides the inner membrane, and there is a host-cell membrane that provides the outer «mitochondrial» or «chloroplast» membrane. There have been several lineages of protozoans discovered to have been engulfed by algae, in particular. We aim to present the idea that social connections, economic connections, institutional connections, and power connections within a power structure are all part of what creates life through these descriptions. It is, therefore, essential to realize that the lives of animals in a city affect the lives of humans in a city as well. As a result, these networks are able to continue to exist in a city and thus cause these networks to continue to exist as well. There are some practical tools that can be used in order to draw and describe such an abstract and theoretical concept. As a part of network theory, network statistics, and so on, these tools will be described in more detail. We will begin this chapter by discussing the concept of a network, which includes the identity of a graph, as well as concepts such as probability, in the first part of the chapter. The aim of this writer is not to educate the reader about the mathematical issues presented but rather to simply provide a list of the essential mathematical tools needed to manage the transition process, which was introduced in chapter 1, and how these tools relate to the transition process introduced in chapter 1 that can be used to manage the transition process if we are aware of it. You will find throughout the second chapter that the concepts discussed in chapter one will be applied in a practical way in order to be able to effectively manage the transition process. What follows is our discussion about the hamming distance after the concept of endosymbiosis. There are two types of research that will be presented by using hamming distance, cluster analysis, and the mathematics behind all three of these. To begin with, it involves hammering distances and drawing urban units in Calabria based on economic activities and networks based on the scope of the local economy. The second method involves the study of Calabria based on network studies as well as the relationship between cluster analysis and network studies. As we continue to discuss the transition process in the following two chapters, we will analyze the toolbox in greater detail in chapter two; then, we will describe the concepts involved with the thesis's main topic in chapter three; and finally, two new concepts in the transition process will be discussed and used in chapter four. The final part of the paper is dedicated to explaining the results of the research.

2. Network theory

According to the theory of networks, graphs are representations of symmetric or asymmetrical relationships between items that are discrete. Computer science and network science are closely related to the subject of graphs. It is possible to define a network as a graph in which each node and edge has a set of attributes. There are many other disciplines that use network theory, in addition to those mentioned above. In addition to logistical networks and the internet, network theory has been applied to gene regulatory networks, metabolic networks, social networks, and epistemological networks. Collecting and analyzing network data has been systematic in specific select fields of science since at least the 1930s (Hill, 2002) , and it has subtle roots that date back centuries. Since the turn of the 21st century, network-centric analysis has gained more prominence and sophistication as a method of scientific inquiry; with practitioners from a wide variety of fields ranging from the physical and mathematical sciences to the humanities and social sciences, the use of network theory provides us with an understanding of phenomena around us by treating core elements of the world around us in a systematic manner in order to consider them more sincerely systematic manner. There is a correlation between the members of a network according to its meaning. A network is a metaphor that tells us not just about its literal meaning but also about a theory or a method that helps us to understand the world by describing the scope of a complex relationship between its members. A network can be used to identify driving elements, fixed elements, relationships, distances, correlations, and divergences between them. In a previous chapter, we discussed how we are working on developing a method that can enable us to detect relationships in physical space based on identity, social, and economic factors. In the city, physical relationships were meaningful thanks to the logistical processes used to manage them. The main objective of our study is to examine social relations and their influence on profit-making, prosperity, and public welfare and to create a space for the transition by examining how these relationships influence profit-making, prosperity, and public welfare. We can make all the aspects necessary in making a conceptual framework by looking at networks from a network perspective without considering them as tools or elements in making a conceptual framework. Humanity, the environment, and the economy are inextricably tied together in a complex network that illustrates how they are related. This study aims to examine the economies of a region in Europe and a city in the United States through a network scope. Finally, we provide policymakers with a dashboard that allows them to visualize the identity of a city using quantitative and qualitative measurements by comparing the various layers that make up the city's identity.

2.2.1.Why network

Recently, it has become clear that network data - that is, measurements taken from or of a system conceptualized as a network - has become an increasingly popular topic of research across a wide variety of disciplines (McIntosh, 2000; Borgatti & Halgin, 2011; Lin, 2017; Liu et al., 2017) . It is becoming increasingly common for researchers in biology, bioinformatics, physics, computer science, and economics to collect and analyze data from a network-centric perspective (Barabasi & Oltvai, 2004; Fang et al., 2007; Rahman et al., 2020; Shy, 2011) . Recent interest has been sparked by the often-repeated statement, "We live in a connected world" (Mulgan, 2011). In the popular press, we see constant examples of how institutions (governments, for example) and processes (economies, for instance) are interconnected, as well as how human systems are connected to natural systems (for example, how humans influence the environment and climate). For instance, the Oxford English Dictionary defines a network as a collection of interconnected things in its most general sense, which can be seen as a collection of interconnected things. Although it is typical for the terms 'network' and 'graph' to be used interchangeably, since networks are represented formally, with graphs of various kinds, for mathematical purposes, it is not uncommon for the terms to be used interchangeably. There is no doubt that graph theory, in addition to its mathematical foundation, played a significant role in the invention of network-based analysis in the sciences. Euler gave proof in 1735 (Di Giovanni et al., 2019) that the impossibility of walking the seven bridges of that city only once would prove it was impossible to do so by showing that it was impossible to do so. Since then, this seed has been planted in several critical areas worldwide, particularly since the mid-1800s, when it began to spread. Konig is regarded as one of the first architects of formal underpinnings in mathematics. The study of electrical circuits and molecular structure has always included a network component dating to Kirchhoff (Broussely et al., 2003), as has the study of electrical circuits since Cayley (Pipes, 1955). Networks were integrated into transportation, allocation, and other problems during the mid-1900s due to the growth of operations research and computer science. Social interactions within groups were studied by a small subset of sociologists during that time using mainly qualitative approaches. Network analysis was also developed as a way to describe social connections within groups during that time. In order to explain this growth, it is essential to take into account two important factors:

1) Scientists have increasingly abandoned reductionism in favor of a systems-level perspective during the last century, and

2) the availability of high-speed storage, retrieval, and management of data. In recent years, network data - that is, measurements taken from or of a system conceptualized as a network - has become an increasingly popular topic of research across a wide range of disciplines on a wide range of topics, primarily because it has emerged within a wide range of disciplines as an increasingly popular research topic. Consequently, fields like systems biology have been pursued aggressively due to the current push toward a better understanding of how different components of the human body work both at the genetic level and further than that. It is essential to understand that analyzing network data is a difficult task since it involves quantities of a relational nature, either explicitly or implicitly, which can present a challenge. Because of this, measurements tend to be both high-dimensional and dependent. As these data tend to be large in volume, computational tractability is a general concern when developing and using statistical methods and models because these data are often large in volume. There is a growing body of statistical theory and methods that focus on analyzing large amounts of data that are highly dimensional, dependent, or massive. It is often the case that when analyzing network data, each of these characteristics is present in a unique manner. There is a chance that there will be an entity with some or all of the topology of such a network in its possession. Electrical circuit manufacturers need to start with schematics of how their circuits are designed and for telephone service providers to know where their lines need to go. There are a wide variety of ways through which the connection can be made. It can be a physical connection, such as a fiber optic cable or a gas line, or a virtual one, such as a wireless link between a cell phone and a nearby tower or a flight between two cities. It is often the case that when discussing these networks, the focus is often

focused on the flow of some corresponding ‘commodity’, which may be internet traffic packets, freight carried by trains, or electricity in some cases. Since the 1930s, it has been believed that social networks (i.e., networks that represent interactions between social entities or ‘actors’) have been studied systematically for the most extended time, dating as far back as the 1930s. The most common type of entity that can be considered as such is a person or group of people, but animals can also be considered as such. Several factors can influence how social interactions occur in this area, including the nature of the units and large groups of people. In this work, we focus on the quantitative analysis and characterization of social structure, i.e., to measure social interactions and analyze the topologies of social networks that result from those interactions. It would be fascinating to know what factors influence the tendency of persons to interact with each other and who interacts with whom? The question becomes, “In a network,” the question becomes, “What are the reciprocal relationships? Is there a connection between friends of friends and friends of friends? Which social groups are present within the network? What are the power brokers, and where do they originate? “The question is, “Where does the power come from, and how can it be harnessed?”. Biological systems, at all scales, can be represented by networks, which are natural and familiar tools. What is the similarity between the roles that actors play, and what are some of the differences? As a natural and common tool, networks can describe biological systems at all scales and worldwide. There is interest in several intracellular networks, for example, those describing gene regulation, protein binding affinity, and metabolite participation in biochemical processes, which are of importance to us. A well-known example of an intercellular network is an intercellular network that is formed between cells in the body. A map of information networks that are informative is often a non-trivial task of considerable interest due to their often-massive size and the difficulty of mapping them effectively. The structure of such networks is also generally of great interest to researchers, especially when it comes to questions such as which nodes are connected to many other nodes, whether certain subgraphs with close connections can be found, and what changes occur in the sizes and structures of such networks over time.

2.2.2. Background on graphs

We use several languages and infrastructures from graph theory in many of the applications we develop; By using these tools, it is possible to manipulate and describe networks and the data associated with them. There is a general understanding that when we refer to a network, we mainly mean a collection of elements along with their interconnections. It is this notion that is refined by the subfield of mathematics known as graph theory, which is a branch of mathematics. There are definitions, tools, techniques, and results related to graphs and their properties, which are useful for discussing graph properties. There are several verticles in the graph *G=(V, E).*

Nodes are the vertices. In this graph, edges are also called links. E consists of ordered pairs of distinct vertices, which are connected by edges; The number of edges $N_e = |E|$ and the number of vertices $N_v = |V|$ are sometimes referred to as the size of the graph and its order. There are many ways to label the vertices, such as $1,\ldots, N_v$, and the edges, analogously, without losing generality. *Subgraphs that are impelled from G have vertices called V and edges called E.*

If each vertex of graph G has an ordering, a digraph is another word for directed-graph. edges are in two types, i.e., directed edges and arcs. In general, an arc has two directions, **i.e., [u,v]** with the tail u pointing in the direction of the head v. As a simple concept of connectivity, the concept of adjacency can be considered one of the most basic. The vertex u and edge v can be considered adjacent if they are connected by an edge in E. If there is an edge in E connecting vertex u to edge v, then the two are considered adjacent. Also, two edges $e_1,e_2 \in E$ converge on the same edge under the condition that they are connected by the same edge V.

A vertex, $v \in V$ can be defined as a case on an edge $e \in E$ if *v* ends at *e*. Consequently, D_V is equal to how many edges are on incident *v*. in order to make the degree sequence of G, the vertex degrees D_V is arranged in non-decreasing order. It is also possible to discuss graph movement in this context. In graph **G,** a walk with endpoints $[v_0, e_1, v_1, \ldots, vl_{-1}, e_l, v_l]$ is an alternating sequence between v_o and v_l. In length, this walk is of a length of l. Walks can be divided into two types based on their lengths: trails, which have no repeating edges, and paths, which have no repeating vertices. There are the same vertices at the beginning and at the end of a circuit, which means that they are equal. As well a cycle is a set of at least three vertices with the same beginning and ending vertices but with different vertices in between. It is important to note that acyclic graphs do not contain cycles. Consequently, it is natural for these notions to generalize when it comes to digraphs. Directed walking from v_o to v_l, for instance, travels between arcs in v_o and v_l. When vertex v is reached vertex u in graph G, it is said that the graph is connected. Graphs are composed of maximally connected subgraphs, which are called components. The connectivity property of this connected subgraph of G would be ruined if any other vertex in V was added.

The concept of connectedness in graphs can be defined in two different ways. Digraphs G have weak connections; this happens when it has a weak connection to its underlying graph. It can be said it is no longer 'tail' and 'head'). If every vertex v can be reached by a directed walk from every vertex u, it is called strongly connected. A graph distance is commonly defined as the distance between two vertices between the shortest path(s) connecting them (or infinity in the case there is no shortest path). In addition to geodesic distances, shortest paths are also called geodesic distances.

In a graph, the diameter is a measure of the length of the longest distance in the graph. Graph G may also be decorated with numerical values at the vertices, edges, or both of them. Edge weights are commonly used to present edges, e. In a weighted walk, the edge set E itself would be represented by a set [we] corresponding to such weights, i.e., we = one if $e \in E$ and 0 if $e \notin E$. Weighted walks are measured in length by their sum. Thus, distance can be generalized in this way. It will be clear from the discussion that it is often useful to use matrices and matrix algebra as a tool. The analysis of network data with the goal of defining a graph and its characteristics by modeling network data and later analyzing it. The connectivity G of a graph can be viewed in the following way: *Nv×Nv binary*, symmetric matrix A with entries A_{ij} = 1 0 In any case, $\{i, j\} \in E$, where set *to*$1,\ldots, N_v$ V is defined generically by the elements in it, and edges are explicitly represented by pairs of vertices i, j in V.

Edges connecting two vertices in G are represented by nonzero row-column indices, and edges connecting no vertices are represented by zero indices. Adjacency matrices are used to store connectivity information as well as generate additional information about G through certain operations on A. additionally, a matrix that captures the basic structure in G, which is the incidence matrix B, can also be viewed as a binary matrix with entries. We can demonstrate this when we consider B as a sign inside the matrix in which "1" indicate an arbitrarily assigned 'orientation' that relates to the mentioned edges. It then can be shown that $B\tilde{}B\tilde{}T = D - A$, in which $D = \mathrm{diag}[(di)i\in V]$ is a diagonal matrix containing the degree sequence. The $Nv \times Nv$ matrix $L = D\text{-}A$ is, indeed, of considerable importance and is called the Laplacian of graph G.

G's structure can be revealed by its eigenvalues and eigenvectors. Due to the fact that L is a positive semi-definite matrix, it has only positive eigenvalues. Additionally, since $L_1 = 0$, where 1 and 0 are nv ×1 matrices of ones and zeroes, the smallest eigenvalue of L equals zero.The second smallest eigenvalue, λ_2, is significant and probably the most significant. Thus, for instance, the larger λ_2 is, the more 'connected' G is, making it harder to put G into subgraphs that are disconnected since it needs to have some edges removed from G. In this way, graph data structures and algorithms can serve as practical tools for analyzing network data which are converted from purely mathematical objects. G can be represented using two different data structures. In the first case, there is the Nv ×Nv adjacency matrix

A mentioned previously. Nevertheless, the condition that the graph is big, especially if it is sparse (e.g., if $Ne \sim Nv$). Traditionally, adjacency lists have been preferred. As opposed to this, adjacency lists store information only about edges present within them. so they will be prominent and filled with zeros in such a case. For graph G, an adjacency-list representation is simply an array with a size of Nv that is ordered according to The array consists of a list of vertices arranged according to the ordering of the vertices in G. An edge connects the i-th vertex in the i-th list. Alternatively, vertex lists can be thought of as two-column lists of all edges connecting vertex pairs. An important consideration when it comes to the analysis of network data is the algorithmic complexity. Computational complexity theory identifies two types of problems - those that can be solved by an algorithm running in polynomial time and those that cannot be solved that way. When there are n inputs, polynomial-time algorithms will run in time O(np) for some p > 0. Super-polynomials are algorithms that are not polynomial for any choice of p. Combinatorically exhaustive algorithms, for instance, run in O(an) time for some a > 1. Unless the n is small, it is not feasible to wait for super-polynomial algorithms to complete. Graph algorithms usually vary in complexity according to both n and v. A linear scaling of run time for such algorithms (i.e., with p = 1) would be ideal

2.2.3.Probability

Probability and statistics are briefly discussed in this chapter. The purpose of this document is not to provide a comprehensive presentation for principles of probability and statistics. This section does not discuss terminology or notations; rather, it explains the concepts involved in calculating the probability of an event A ⊆ Ω by P(A) with P.

A Kolmogorov axiom (Uspensky, 1992) states that every event receives a number between 0 and 1, depending on the function used. We make the following assumptions:

1) $P(A) \geq 0$ any event A, (ii) $P(\Omega) = 1$, and

2) $P(A \cup B) = P(A) + P(B)$ for disjoint events A and B (i.e., such that $A \cap B = 0$).

The two events are independent in this case since *P(A ∩ B) =P(A)P(B)*. Whenever *P(B) > 0*, A's probabilistic condition assuming B is *P(A|B) = P(A ∩ B)/P(B)*. To establish A and B's independence, we can show that *P(A|B) = P(A)*. As a result of *P(A ∩ B) = P(A|B)P(B) = P(B|A)P(A) and P(B) = P(B|A) P(A) + P(B|Ac)P(*A_c*)*, more precisely *P(B|*A_c*)P(*A_c*)*, we can obtain the Bayes rule

(Waller & Duncan, 1969), *P(A|B) = P(B|A)P(A) P(B|A)P(A) +P(B|A$_c$)P(A$_c$)* . Event A and event B out of three events, A, B, and C, have conditional independence if $P(A \cap B|C) = P(A|C)P(B|C)$. Experimental measurements are represented by random variables as mappings from samples to IRs in real numbers. It is possible to express the distribution of X as 'FX,' commonly expressed as $X \sim FX$.

PDFs represent probability density functions, PDF if X occurs discretely and probability density functions (PDF) if X happens continuously. The expectation of a random variable is expressed as $\mu X \equiv E(X) \equiv EX(X)$. For discrete random variables, it is the integral of *fX(x) when fX(x) > 0*, whereas for continuous random variables, *fX(x) is the sum of fX(x). It may be shown that E(IA) = P(A) for the event A (i.e., IA is one if A occurs, zero if not). For a function g(x), a random variate Y = g(X) is simply EY (Y) = EX(g(X)).* Typical examples of g are g(x) = xk, for k being a positive integer, which gives us the k-th moment $E(Xk)$ of X, and $g(x) = (X - \mu X)2$, resulting in $\sigma X2 \equiv V(X) \equiv E(X - \mu X)2$ of X. The standard deviation measures the variability of X, by linearly transforming X into g(X) = cX + b, X becomes a random variable with E(cX + b) = cE(X) + b and V(cX + b) = c2V(X). These concepts can be used to model a wide variety of random variables. In the case of random variables X and Y, their joint CDF (Cumulative Distribution Function) will be written *F_X, Y (x,y) = P(X ≤ x, Y ≤ y),* as well as their joint PDF in a similar manner to fX, Y (x,y). When dealing with discrete random variables, density marginals f_X and f_Y can be calculated by integrating (or summarizing) f_X, Y (x,y) for each value of y or x, accordingly.

A pair of events X and Y are said to be independent if $P(X \in A, Y \in B) = P(X \in A)P(Y \in B)$ in every case except A and B, where f_X, Y (x,y) = fX(x) fY (y). Because of this last fact, we also have E(XY) = E(X)E(Y). In the case of n random variables $X_1, \ldots, X_n$ referred to as vectors or matrices, bold faces are used (e.g., X = (X1,..., Xn)T). The PDF will be denoted by $f(x) \equiv f(x1,\ldots,xn)$, the mean vector, by $\mu \equiv (E(X1),\ldots,E(Xn))T$, and the variance-covariance matrix, by

$$\Sigma \equiv V(X) \equiv [Cov(Xi,Xj)]i,j,$$

where

$$Cov(Xi,Xj) = E[(Xi - \mu Xi)(Xj - \mu Xj)] \text{ and } Cov(Xi,Xi) = V(Xi).$$

We can calculate the correlation by scaling the covariances by their standard deviations.

$$\rho Xi,Xj = corr(Xi,Xj) = Cov(Xi,Xj)/\sigma Xi \sigma Xj.$$

In the case where X is CX+b, where C is an m×n real-valued matrix and b is an m-length real-valued vector, then

$$E(CX+b) = CE(X) + b \text{ and } Cov(CX+b) = CV(X)CT$$

for any choice of i_o,...,im_{-1},im, j, called states, and any positive integer m, commonly called an index.

Stochastic processes occur discretely in time, such as Markov chains (Geyer, 1992). According to the first equality, the distribution of a process at time *m+1* depends only on the process's historical state up to time m. In contrast, m does not depend on this conditional distribution. The values P_i **j** are called transition probabilities. If the Markov chain starts in state i, and n units of time later (or 'transitions'), it reaches state j, $P(n)_{i\,j}$ indicates the probability for all states i, j, P_{ij} (n) > 0 for some finite n, there can only be a finite number of transitions. When certain conditions are met, the stationary distribution of irreducible chains can be defined. call it:

$$\{\pi j\},$$

where

$$\lim n\to\infty P(n)\, i\, j = \pi j$$

exists for each state j, *with* $\pi j \geq 0$ *and* $\sum j\, \pi j = 1$, independent of the starting state i. Because network data and statistics have a unique relationship, they often present unique challenges that are not found in 'standard' statistics problems. There are two main reasons for these challenges: the dependent nature of the quantities and their multidimensionality.

This subchapter is a scientific summary of numbers of references dealing with probability definition, static analysis and transitional mathematic (Merris, 1994; Aiello et al., 2001; Kolaczyk & Csárdi, 2014; Becker, 2017; Chatfield & Collins, 2018) . The author has no intention to state such concepts as the neither findings or state of the arts, but it is important to review the principles of the network probability rules to check the finidings section of this chapter.

2.2.4.Visualization of the network

It is natural to make a network-based representation of a complex system under study in order to make a visual representation of it. There are several distinct steps and important decisions involved in creating these images, much like the steps in producing a cartographic map.There is no doubt that visual imagery plays a fundamental role in network analysis, as well as in many other quantitative sciences or fields. It has been true for a long time, including the earliest days of computers and computer graphics.Freeman (Freeman, 2004) claims that Moreno and his colleagues pioneered the development of visualization methods for social network analysis due to their pioneering work in the 1930s. In the early days of the Visualization of networks, hand-drawn, annotated graphs of relational data were used to visualize network data. When describing a system, it is often misleading to use vague terms such as "the network," as it may be possible to represent a given geographical region in many different ways depending on its topography, population patterns, geology, human use of land, etc. It is possible that a network can be represented in many different ways as well. It is also important to note that there are considerable challenges inherent in communicating the information contained in a network graph effectively with only two-dimensional surfaces such as printed pages or computer displays. It makes visualizing such representations non-trivial, regardless of whether they represent complex systems or not and whether they are network graph representations. The visual analysis of high-dimensional data poses similar challenges as Tufte and colleages have eloquently explained and illustrated in his lecture (Aaser et al., 2017). Various fields of mathematics, algorithms, aesthetics and human visual systems play an important role in this field, but the field is still quite young, and the research in this area is quite active. Using a network of connections to visualize a complex system is similar to using a cartographic map or a geographic map to create a map of an area on the ground to represent geospatial data. In order to produce a network map, three stages need to be completed:

Firstly, data should be gathered from a system that there is an interest in; As a second step, we will construct a network graph from the data we have collected; and as a third step, we will assess the network A visual representation of the representation can also be created in addition to the textual representation.

Obtaining data from the system that needs to be mapped is an essential part of network mapping. No doubt understanding the data collection protocol plays an important role, regardless of whether the data is collected by us or by someone else. There is a wide variety of tools and techniques used in data collection that vary greatly depending on the discipline and the type of data that needs to be collected. A network graph is a representation of a network that can be used for visualizing the network.In other words, even if the elements in a system are closely related, different definitions of 'elements' will lead to different network graphs, even if the elements in system are closely related. Even though 'elements' in a study are well-defined, there may still be a need for choices, such as when different 'scales' of categorization exist for elements in a given study. There is an important thing to remember when assessing association, which is that not only does what we choose to measure in a system matter, but it is also important to consider what remains unmeasured within the system. An interactive map can fast become cluttered if the network graph has more than a few hundred vertices. For example, In some cases, it may still be the case that there is a problem with the analysis unit. Our goal is to visualize a network graph in order to be able to visualize network measurements G = (V, E). Graphs are typically represented geometrically as points, circles, squares, or any other combinatorial structure for the vertex nodes and as smooth curves for the edge nodes using geometric representations. In the case of graphs, it is usually two dimensions rather than three dimensions or abstract surfaces that are used. As a result, we will be focusing our attention on this setting. The lack of edges crossing in planar graphs also makes them a very natural starting point for graph drawing since they do not have any edges crossing.

Drawing algorithms for non-planar graphs build upon algorithms for displaying planar graphs by drawing a subgraph of the non-planar graph and then augmenting it with the rest of the graph to display the full graph.In order to effectively communicate relational information visually, network mapping is used to visualize the relational information. Network mapping can be divided into three phases: 1)The collection of data, 2)The representation of graphs, and 3)The Visualization of the data. It has also been noted that Brandes et al. and Brandes have provided similar descriptions of network visualizations. As we break down their characterization into three main elements: system, design, and algorithm, it is possible to provide a more refined breakdown of the two.

Several recent studies have emphasized the methodical nature of presenting issues related to the collection of relational data, such as Scott and Wasserman, Faust's books, and Marsden's review of Scott and Wasserman's books (Carrington et al., 2005) . Kaufmann and Wagner (Kaufmann & Wagner, 2003) provide a comprehensive overview of network graph visualization in their book Network Graph Visualization: Principles and Techniques. As mentioned earlier, there are many situations in which it is unclear what constitutes 'ground truth'; there are even some situations where it might even be argued that it is not clear whether 'ground truth is the best representation of the information in many cases. Using a schematic map of the city subway system compared to a geographically accurate map illustrating the same system, Bottger (Böttger et al., 2008) illustrates the difference between the two maps nicely. Although it is arguably more accurate to show the subway on a geographical map, the schematic map is easier to use for an average rider and is more useful to them in terms of ridership data. As a result, it is tempting to wonder to what extent the network map derived from the original measurement matches the information captured by the alternative measurements, for example, if one has some sense of the reality captured, such as an alternative set of measurements for the same system of interest. They take some initial steps in this direction in mapping 'science' within the context of Klavans and Boyack (Boyack et al., 2005).

2.2.5.Vertex and Edge characteristics

There are different matrices for drawing and describing a complex system's structural and point-by-point aspects and the connections inside the system if we consider a network as a picture of a complex system. It is essential to understand that when a network is created, and a graph is drawn, we can interpret it based either on the network's topology or global issues. There is a common misconception that when we analyze a complex system, the most critical aspect is that we can rephrase or make the central question since our approach to analyzing a complex system is in a question-and-answer scenario. In order to solve the question correctly, we need to construct a matrix structure with matrices and interpret those matrices. As far as our thesis is concerned, we are trying to map out few phases in a transition process. During the transition of an urban system, we refer to it as a complex system and interpret the two layers of this system in separate ways. Having established the question as evident, we now set out different points, which we will call vertexes, and then interpret these points from the perspective of importance, centrality, and density concerning each other. Through this interpretation, we can analyze our network structurally and understand how we can change its qualitative aspect into a quantitative aspect to analyze it. Various characters are referred to as points and lines that form a network, while some are referred to as comparisons of the whole network with other networks. The aspects relating to the network are of secondary importance since the scope of the study is focused on the transition; we are primarily concerned with the resiliency of the points and how they establish a sense of coherence in the whole system. In order to analyze the points and the edges in the graph, we usually introduce two main topics as a means of accomplishing that. We will begin by defining the degree of communication of each point, which is a function of all the lines that go into and out of a particular spot to connect it to the other points in its vicinity as a first step. In undirected networks, the entrances and exits are both one line, while in directed networks, the outdegree of A is one, the in-degree of B is one, and the outdegree of A and the outdegree of B is zero.

We can get the degree of each point in our network by using degree distribution, which can be drawn like a histogram since degrees are nonnegative and sequential, enabling us to get the degree of each point in our network. Then, we could see if the degree distribution is normal, has a skew distribution, or is part of a logarithm when we draw the degree distribution. By drawing the degree distribution, we could determine our network's coherence. In the last decade, there has been an increase in the amount of knowledge about Data science, resulting in the majority of networks becoming logarithmic. As a result of these networks, the Power-law exponent (scaling law) is observed (Aiello et al., 2001). There is a principle known as the power law (also known as the scaling law); basically, if one quantity changes relative to another, the other quantity will change relative to the first. Let's examine the most straightforward example in order to understand this law. A square's area quadruples if its side length is doubled (for example, from 2 to 4 inches). It can be expressed as

$$Y = k\, X\alpha,$$

where:

- Variables X and Y are of interest,
- α is the law›s exponent,
- k is a constant.

When one quantity changes, another quantity changes in a negative manner, such as in Y = X-1.

We can determine the distribution's homogeneity or heterogeneity by drawing the distribution's degree. This way, we will be able to identify if there is any continuity in the network or if there are any critical points in the network. We do not need to emphasize the fact that there is a necessity to have a high level of connection between points; this should go without saying. It is essential that for a complete and sustainable transition, there is a high level of connectivity at a point that causes diversity. Consequently, we use Power Law to analyze a network to see if it has a satisfactory amount of diversity in terms of the number of nodes.

2.2.5.1.Degree

We can use this function to determine how connected V is to other vertices in the graph. Furthermore, it is possible to define a range of valuable measures of the overall connectivity in the graph by aggregating the vertex degrees $[d_1,\ldots,d_{Nv}]$ by multiplying them together. This article discusses a variety of measures that can be applied to these situations. As a background, it is essential to note that these measures are typically applied in separate ways for sequences of degrees [dv_{in}] and [dv_{out}] of directed graphs.

Degree distributions

When a network graph is discussed, G describes $\mathbf{f_d}$ as the fraction of edges $\mathbf{v \in V}$ with degree $\mathbf{d_v = d.}$ the degree distribution of G is the collection of*{ fd}d≥0*. G. To produce this histogram, the degree sequence is characterized by bins of equal size centered around a nonnegative integer. Due to the degree distribution, it is possible to summarize the graph's connectivity quickly. It is necessary to remember that the examples above are in no way very complicated. Using degree distributions is considered a more effective method of describing large graphs.

f_(d)∝d^(-α)

Several fields of science have discovered over the past ten to fifteen years that approximate power-law degree distributions are frequently observed in the behavior of networks. In the beginning, most people were surprised by the structure of the data since it was different from circuit networks and the traditional random graphs that had been studied throughout most of the 20th century (Bencomo & Belaggoun, 2014). Instead of a heterogeneous distribution of vertex degrees across the graph in the latter case, the latter case generally shows homogenous vertex degrees across the graph. The degreed distributions, then, are not diffuse but relatively concentrated, and their decay in the time domain can be described using exponential decay rather than power laws as the distributions decay. Power-law-like network graphs exhibit power-law-like behavior as the number of nodes increases in our study, not simply growing in size.

logf_d ~ C- αlogd

F ̅(d)=1-F(d)~d^(-(α-1))

$$\hat{\alpha}_k = 1 + \hat{\gamma}_k^{-1}, with\ \hat{\gamma}_k = \frac{1}{k}\sum_{i=0}^{k-1} log\,\frac{d_{(N_{v-i})}}{d_{(N_{v-k})}}$$

As tempting as it may seem - and indeed as natural as it may seem - to wish to summarize observed degree distributions, whether homogeneous or heterogeneous, is a natural desire. For example, a numerical study on this issue was conducted by Goldstein, Morris, and Yen (Goldstein et al., 2004).

The final point is that understanding the mechanisms through which power-law-like distributions of degree emerge, both theoretically and practically, has always been a topic of intense interest beyond simply summarizing and interpreting them.

2.2.5.2.Centrality

Many questions can be answered by understanding the 'importance' of a vertex in a network graph. Researchers over the past few years have proposed several centrality measures. However, as Freeman (Freeman, 2004) observed in 1979, "centrality is still not universally understood, nor its conceptual foundations are fully agreed upon today," which is still valid. Nevertheless, some attempts have been made to categorize various centrality measures by arranging them according to concepts or dynamics, for example, 'distance,' 'flow,' 'feedback,' and 'control,' as in Freeman and Brandes and Erlebach, or by the method by which they are calculated, as in Borgatti and Everett (Borgatti et al., 2009).

Centrality Measures

A measure of closeness centrality can be used to capture this concept. Sabidussi introduced (Sabidussi, 1966) the standard approach by allowing the centrality of a vertex to vary inversely with the total distance between the vertex and all the others in a graph.

$$c_B(v) = \sum_{s \neq t \neq v \in V} \frac{\sigma(s,t|v)}{\sigma(s,t)}$$

$$c_{Cl}(v) = \frac{1}{\sum_{u \in V} dist(v,u)}$$

Where dist(v,u) represents the geodesic distance between vertices $u,v \in V$, it is typically normalized for comparison across graphs and other centrality measures to [0,1] through multiplication by a factor N_{v-1}. According to this perspective, a vertice in a network graph is defined as having significance based on its location in relation to the paths in the graph. Vertices that sit on many paths are likely more important for communication purposes than vertices that sit on a few paths. It is said that a vertex is 'between' other vertex pairs if it has the property that it is betweenness. The most commonly used betweenness centrality, as defined by Freeman, is the centrality that consists of the following:

Where σ(s,t|v) Measures how many shortest paths there are between two points **v,** and

$. \sigma(s,t) = \sum v \ \sigma(s,t|v).$

in a situation the unique way, $c_B(v)$ indicates how many shortest paths pass through *v*. One can reduce the number of paths to pass through the unit interval by dividing by $(Nv- 1)(Nv- 2)/2.$

All pairs of vertices are calculated by adding up their betweenness centralities $c_B(v)$ entails computing the sum of the lengths of the shortest paths between each pair of vertex. Thus, if implemented straightforwardly, the last step dominates the overall computational burden since each n sum requires $O(N_{v2})$ time. As a result, the algorithm is $O(N_{v3})$; as large graphs get larger, this can become prohibitive. In contrast, Brandes proposes a betweenness centrality algorithm that runs in a single direction $O(N_v N_e)$ time on unweighted graphs and $O(N_{v2} \log N_v + N_v N_e)$ time on weighted graphs and requires only $O(N_v + N_e)$ space, as compared to the $O(N_{v2})$ demand of the straightforward algorithm. In order to achieve these improvements. Specifically, we exploit a clever recursive relation for the partial sums $\sum t \in V \ \sigma(s,t|v)/\sigma(s,t).$ In addition, there are three types of centrality measures based on notions like 'status,' 'premium,' and 'rank.' These measure centrality by the number of neighbors a vertex contains.

A linear system of equations with appropriately defined eigenvectors can typically express these measures as implicit in their definition. There are many such eigenvector centrality measures. Using Katz and others' (Sharkey, 2017) work as a guide, Bonacich (Bonacich, 1987) developed a centrality measure of the form.

$$c_{Ei} = \alpha \sum_{\{u,v\} \epsilon \ E} c_{Ei}\,(u)$$

The vector $cEi = (cEi(1),...,cEi(Nv))T$ refers to the solution of

$AcEi = \alpha\text{-}1cEi,$

which specifies the connectivity matrix A on the network graph G.

According to Bonacich, the value of **α-1** is the largest eigenvalue of A, and hence c_{Ei} is the corresponding eigenvector. A›s largest eigenvector will be simple when G is undirected and connected, and its eigenvector will be nonzero and have the same sign. As a result of the orthonormality of eigenvectors, the absolute value of these entries will always lie between 0 and 1. Commonly, eigenvalues and eigenvectors of matrices are calculated. Computational linear algebra textbooks generally describe the power method. A symmetric matrix, such as that found in undirected graphs, is guaranteed to converge under this iterative method.

Regarding the number of iterations, the convergence rate to c_{Ei} will behave as the ratio of the second largest eigenvalue of A to the first. It is roughly equivalent to the other two methods described above since only matrix-vector multiplication is required in the power method. As a result of different interpretations of the term central, each of the three centrality measures defined thus far closeness, betweenness, and eigenvectors has been well justified. It may not be surprising, but the results obtained when applying these interpretations can differ because they differ from each other.

3. Economic Network

As a result of the current economic crisis, there is a pressing need to rethink and reshape some paradigms in the field of economic theory. Our research focuses on identifying new perspectives on how to make networks more resilient and efficient (i.e., to achieve maximum benefits) despite their complexity (i.e., determining how to make them more reliable and efficient). As a first step towards creating better policies, a causal analysis of time series is required to mitigate conflicts between individual interests and global failure risks in order to reduce the likelihood of global failure. It has been shown that when new links are evaluated too quickly, the formation of new networks can become inefficient, which corresponds to findings about assimilating new knowledge and innovation in knowledge-based industries after the dynamics of innovation with knowledge transfer and growth have been simulated. A variety of stochastic algorithms have been found to be useful (for example, random, scale-free, or small-world networks) in calculating real complex networks, including a metabolic network, a genetic network, an infrastructure network (for example, roads and power lines), networks of communication (such as the Internet or cell phones), as well as social interaction networks (collaborations). As a result, when comparing network structures from different disciplines, such as economic networks to medical networks, several universality classes can be identified, such as the characteristic of the degree of variation (the number of links) among nodes. The fat tail indicates that, since the degree distribution scales with a power law, there are only a few banks that interact with a wide range of other banks in an interbank network. In order to organize the network, similar investment behaviors are clustered together into clusters. A regularity in international trade networks could also be traced if one were to look at regional investment networks, ownership networks, and many other types of networks. Alternatively, aggregate patterns, such as power law distributions of degree, are not a reflection of the underlying dynamics of the agents. For example, a preference for countries or banks with good connections can be mistaken for an indication of the underlying dynamics of the agents. Several processes are capable of generating power-law distributions, including preferential attachment, which is one of them. A number of research strands have been emerging in economics and sociology in terms of research on economic networks, while in physics and computer science, other strands have been emerging. Nodes in the network represent firms, banks, or entire countries, and the links between them indicate how they are interconnected, whether through trade, ownership, or credit/debt relationships. A number of ways can be used to form networks, including the addition of agents, the deleting of links between them, or the reversal of the direction of their links. It is important to note that a fundamental aspect of socioeconomics is its emphasis on how relatively simple changes in network architectures can have a significant impact on how agents interact with one another and how these interactions affect their strategic behavior. When plants and pollinators are paired up in a network or ecosystem, it may be possible to contribute to the robustness of ecosystems or markets by combining a combination of highly connected nodes with fewer connected nodes, depending on whether those nodes are considered species nodes or ecological nodes, depending on whether they are considered ecosystem nodes or ecological nodes. Furthermore, it is essential in order to maintain structural stability in a production chain to alternate buyers and suppliers (to prevent triples and establish hierarchies in the process). Economic networks can suffer cascades of failure because of the absence of redundancy, insolvencies due to the characteristics of the flows, and price issues due to noncompetitive buyers, which can lead to cascades of failure. When suppliers are not paid by their suppliers, or when revenue shocks are in the midst of the supply chain, it is possible for bankruptcy cascades to occur. There must also be a focus on local interactions and network properties along with global averages, such as when more firms fail, resulting in higher interest rates all over the world. In order to understand how knowledge, trade, and investments are distributed among agents, we need to study micro-macro network linkages. Behavioral and macro perspectives differ by the way in which they focus on system elements, whereas a behavioral perspective focuses on statistical patterns, which can help explain the differences between the two perspectives. Identifying the pathways through which two largely distinct strands of empirical research can converge can be one of the hardest challenges we face when identifying a strong theoretical connection between micro configurations and macro properties and structures in networks. It is important to identify the mathematical proofs that this relationship exists. In order to analyze these types of economic networks based on a game theory approach (Reinganum, 1981), an equilibrium must be achieved between the potential inefficient outcomes and the potential efficient outcomes, as well as analyzing operational research issues, such as how to find partners and calculate the expected return over a defined period of time in order to analyze these types of economic networks from the perspective of game theory.

It is the complexity of the network structure that poses the greatest challenges to solving these types of problems. The simplification of mathematics has led to the development of a number of mathematical frameworks and simulations that are supposedly capable of solving these problems. The game theory approach suggests that networks can be modeled in the simplest possible way (e.g., as a star or as a complete network in which all participants interact with each other) in order to understand their dynamics. The game-theoretic literature (Reinganum, 1981; Song et al., 2020; Molinero & Riquelme, 2021) highlights incentives as important factors in social network behaviors, such as collaborations, innovation, research, and development, as well as endogenous and induced behaviors, such as those that serve as an incentive for social interaction. A combination of micro and macro approaches, as well as the implications for overall network efficiency, need to be taken into account when taking into account the competition between incentives and aggregate welfare. In a cluster structure, a cluster is formed when at least one node loses a tie when the threshold is exceeded, whereas, above the threshold, clusters form a core-periphery structure. This rule of selecting partners is an example of the local search process for networks where network volatility changes and the structure of the network becomes bifurcated. Determining the simplest assumptions in the network structure that can reproduce complex systems can reproduce the statistical regularities in empirical network structures. There are various rules related to the concept of connectivity (links) and centrality (measured by counting the shortest or randomly selected paths through a node or by recursively weighting the importance of its neighbors) that consider agents based on their characteristics, like how connected they are (links) or how central they are. In order to be able to understand the endogenous behavior of individuals, we are no longer solely focusing on understanding them in the light of their strictly economic motivations. As a result, these models also illustrate the ways in which network-formation rules and supply-and-demand theory are used to account for how link structures constrain the options of agents. There are really no binary links (there are either ones that exist or not) in this model; the links are weighted according to the economic interactions taken into account; over time, their weight can change. Taking into account links at different levels of abstraction, such as Links that are weighted or unweighted and directed or undirected, it is possible to uncover the evolution of topological properties of networks and identify the behavior of the network as a whole over time. We have seen how this works for the example of the overnight money market that we discussed earlier.

3.2.1.Economy of location

Since Birch (Birch et al., 1979) unraveled the American economy by focusing on the individual economic units and identifying how each of them contributes to economic growth, there has been much interest in the role firms play in economic growth. With the increasing availability of micro-level data, several studies have been conducted in recent years focusing on the relationship between firms and employment growth after their provocative statements that Small businesses (Acs, 1992; C. Gray, 2002; Hoogstra & Van Dijk, 2004; Delmar & Wiklund, 2008; Link & Scott, 2012) create most of the new jobs. Studies indicate that have examined the factors that influence the growth of firm employment, three groups of factors can be identified. Firm-specific, owner-specific, and manager-specific are those relating to the firm, the entrepreneur, and to the owner. and to the external factors that are generally associated with a firm's location or environment (Almus & Nerlinger, 1999; Schutjens & Wever, 2000) . Among the factors that affect the growth of firms and entrepreneurs is the presence of factors that influence the growth of firms. In spite of the fact that certain regions have a greater success rate in growing employment than others, no explanation is provided as to why some regions have a higher success rate than others. Putting it another way a result, they cannot determine the reasons for firm employment growth related to the location of the firm. Is there a relationship between the location of a firm and the growth of its employees? In addition, we demonstrate that location has a number of characteristics that are expected to be instrumental to the growth of a firm (for example, population growth, accessibility, spatial clustering, etc.). Despite the fact that regional growth has been widely regarded as the aggregate result of the behavior of economic units over the years since Birch (Birch et al., 1979) , it has not been universally accepted. According to recent arguments, changes in employment in (existing) firms have been underexposed by Van Dijk et al. (Van Dijk & Pellenbarg, 2000) , among others. Locating the factors that determine location characteristics when it comes to practical application, firm and entrepreneur-specific characteristics can also be beneficial (as with identifying the determinants of the firm- and entrepreneur-specific characteristics). In terms of spatial policy measures, detecting locations that are 'strong' and 'weak' is of great importance, as well as identifying those that have 'growth potential' (Poot, 2000) . There are some people, however, who believe that a firm's location has a significant impact on its profitability and the growth of its employees. It is typically the case that regional differences are operationalized rather simply in most studies, even though it has also been shown that regional differences have a considerable impact on the performance of a firm in several studies. Consequently, most studies use dummies that are based only on the regions in which they are conducted. It is possible to tailor spatial variables to reflect the geographical location of companies in different economic sectors based on their spatial variables. The location of the firm can be used to construct variables in which the spatial range can vary by using the techniques of network simulation in order to construct variables. There is a plethora of examples of how to construct variables, but a common one is the use of increments that range from the firm's geographic location to a measure of cluster size. It is the same method that is applied to different variables using varying spatial networks that are applied to several other variables. In recent decades, it has been relatively easy to think about how location affects competition on a global scale. A view that advocates cost minimization, as well as a relatively closed economic system, regards competition as mainly a static phenomenon. Here, it is imperative that you have a competitive advantage in the factors of production that go into the production process. The importance of increasing returns to scale has been increasingly stressed in recent years. The reality is that the competition is very different from what you may think. In order to succeed in a competitive environment, there must be innovation and the pursuit of strategic differences based on innovation. It is imperative for a business to maintain close relationships with its buyers, suppliers, and other institutions in order to improve and innovate on an ongoing basis. A location's ability to affect productivity and, in particular, its ability to increase productivity has a direct effect on its competitiveness. There is a direct correlation between prosperity in a particular location and the use and upgrading of factors in that location. A measure of economic development that can be used to measure long-term sustainable growth is purchasing power parity. The productivity and prosperity of a geographic location are determined not only by how companies compete in the industries they compete in but to what degree they compete. A company's ability to compete in a highly sophisticated industry can be greatly influenced by the microeconomic business environment in its location. It is difficult to capture the business environment of a location because of the variety of factors that influence productivity in a particular location. In order to affect competition in three broad ways, productivity clusters need to grow. The primary benefit of these clusters is their ability to increase the current (static) productivity of the constituent firms or industries, the ability to improve the innovation and productivity growth capacity of the cluster members, and the ability to stimulate the formation of new businesses to stimulate innovation and expand the cluster. A number of advantages are shared by firms, industries, and institutions of various types as a result of external economies or spillovers from one type of industry to another.

Clusters are groups of firms or institutions interconnected through a network of factors that have an immense value than the sum of their parts. In order for clusters to influence the competition in their area, they must take into account a number of factors, such as social relationships, face-to-face communication, and a network of individuals and institutions. In order for clusters to be able to influence competition in a significant way, they need to take into account these factors. Often, it is the case that agglomeration is observed at the level of clusters and locations within an urban economy that is diversified or even at the level of the industry within a city. Many treatments of agglomeration economies focus on minimizing costs due to the proximity of inputs and markets in these economies. These explanations have been undermined because of globalization of markets, technology, and supply sources, as well as increased mobility and lower transportation and communication costs. Globalization of markets, technology, and supply sources, among other factors, have undermined these explanations. Currently, cluster-based economies have taken over narrow industries and urban areas due to the shift to agglomeration economies from narrow industries. Benefits:

1. Inputs and employees who have a specialized skill set;
2. Accessibility of information is of the utmost importance.

Complementary to each other are the following:

1. Complementary products that are buyer-friendly.
2. Strategies that complement each other in terms of marketing.
3. When cluster members' activities are aligned better, complementarities are created between them.
4. Providing incentives to motivate employees and measuring their performance.

Cluster and Innovation:

The advantages of cluster participation over group participation at an isolated location in terms of innovation and upgrading (along with some risks) are numerous. It is important to note that innovation depends on a few cluster characteristics that enhance current productivity in a cluster. In certain circumstances, however, cluster participation may actually retard innovation as a result of a lack of interaction between members. There is no doubt that the uniformity of a cluster's approach to competition reinforces old behaviors, suppresses new ones, and creates rigidities that hamper the implementation of improvements a result. Cluster firms are able to discern buyer trends much more quickly than competing firms that operate on their own. The participation of clusters opens up new potentials for the development of technology, operating methods, and delivery of services. Due to their close involvement in the innovation process, the inputs provided by local suppliers/partners can and do meet the firm's requirements in a more effective manner. In many cases, it is possible to recruit local specialized personnel to fill gaps in order to implement new approaches that require specialized personnel in order to be successful. A product that is composed of complementary elements makes it easier to innovate when it is designed that way. It is essential for a company to be able to differentiate itself from its competitors in order to stand out from them. The pressure on innovation is increasing as a result of a number of factors. In spite of the fact that many of the cluster's firms are unable to stay ahead for long periods of time, they tend to advance much faster than their peers elsewhere. It has been shown that new businesses tend to form in established clusters, whereas they usually do not form in remote locations (branches, ancillary facilities, etc.). There is a better level of information about opportunities within the cluster, and this provides a strong incentive for companies to participate in the cluster. Additionally, clusters are also likely to have lower exit barriers since they require less specialized investment, deeper markets for specialized assets, as well as other factors. It is not uncommon for entrepreneurs based elsewhere to relocate to clusters sooner or later, regardless of the fact that local entrepreneurs are the most likely to join. A lower entry barrier is appealing to these entrepreneurs, as well as the possibility that their ideas and skills will be able to create more economic value. As a result of new businesses being established over time, cluster advantages are often increased over time, which will enhance the depth and breadth of the cluster as a whole.

Cluster and Competition:

There is evidence that clusters and competition play a significant role in influencing the economic geography of cities, states, nations, and neighbors (M. E. Porter, 1998). Clusters are characterized by a combination of competition and cooperation. In spite of the fact that geographically proximate clusters of independent and informal firms and institutions are among the most concentrated forms of an organization along the continuum between markets and hierarchies, they are rarely explored by management scholars. There is a strong correlation between the location of markets and hierarchies. In a local environment, competition is amplified by proximity, whereas local resources and suppliers are prioritized. A co-location can bolster local supplier development, leading to the emergence of new competitors in related industries as a result of rivalry spilling over from the co-location.

3.2.2. Cluster mapping theory and methodology

Clusters are geographically proximate groups of firms, suppliers, services, and institutions that are interconnected that are interdependent through externalities of various kinds. The importance of clusters for firms and associated organizations (such as universities and local governments) cannot be overstated. Clusters are groups of entities that work together to find a way to operate more efficiently and share expertise, infrastructure, technology, and demand in order to reach their goals. As a result, these clusters can play a significant role in driving regional competitiveness and innovation within the region. U.S. cluster mapping was created in response to Porter (M. Porter, 2003)'s definitions of clusters and the definition of cluster boundaries, which formed the basis for defining and defining the clusters for the U.S cluster mapping project (M. E. Porter, 2011). The objects we study (cities, people, genes, industries, etc.) are classified using cluster analysis and numerical methods. Similarly to how industries are clustered within a company (Landau et al., 2011). Cluster analysis, on the other hand, classifies objects in a way that takes into account their relationship to one another rather than based on how they are related to one another, like network analysis, which groups object based on their similarity to one another. Based on the clustering algorithm, each industry belongs to one cluster, each of which is mutually exclusive, as determined by the clustering algorithm. With the use of this methodology, it is possible to measure cluster relatedness between multiple clusters (mutually exclusive) as well as create overlap clusters (with multiple clusters sharing a common industry).

This method distinguishes between traded and local industries based on their geographic concentration, as (M. Porter, 2003) claims. A total of 1,088 NAICS-2007 industries were recorded in the 2009 CBP data, which corresponds to NACE industrial codes in the European Union as well. According to Porter's model, cluster configurations are denoted by the letter C, and clusters are denoted by the letter C. Each configuration is created and assessed in five interrelated steps:

1) determine the degree of similarity between two industries using a similarity matrix Mij;

2) choose a wide range of parameters β;

3) use a function of clustering to make a configuration C which is based on the similarity matrix Mij when the parameters are chosen such as

$(C=F(Mij,\beta)$; calculates performance scores for each C and chooses the most promising C*; and

4) check and redo each cluster in C^* to gauge the final form of cluster definitions C^{**}. Listed below is a detailed explanation of each step of the clustering algorithm that is used. These are the steps that make up the clustering algorithm:

1. Similarity Matrix:

By using a similarity matrix M_{ij}, it allows us to identify how similar two industries, i and j, are by comparing their similarities. An indicator is selected, and similarity is measured to determine the matrix. Several indicators have been identified in the literature, including employment, establishments, and Labor requirements shared by buyers and suppliers, which have all been taken into account. As the user determines the measurement of the similarity among industries, i and j, likewise measures can be used. You can use correlation coefficients, Euclidean distances, Jaccard indices, or other distance measures to determine how far the two industries are separated.

2. Broad Parameter Choices:

A clustering function requires several parameters as input parameters, such as clustering numbers (groups), normalization methods, and starting values, among others. The number of clusters to be included in a clustering analysis must be selected at the start of the process. The number of input-output clusters is reported by (M. Porter, 2003) to be 41 and by (Feser et al., 2005) to be 45.

3. Clustering Function:

As a result of clustering functions being used within each cluster, it is possible to determine which industries are most related to each other. The concept of clustering was introduced with the development of a number of clustering functions, F. Every function generates a new grouping C based on the similarity matrix as well as the parameter selections as determined by each function: $C = F(M_{ij}, \beta)$. Our analysis of the data resulted in the use of two different types of clustering functions there are two types of clustering functions: hierarchical and centroid-based (kmean and kmedian).

4. Performance Scores for Each Cluster

There can be quite a number of different cluster configurations available based on the different similarity matrices, parameters, and clustering functions available. Based on the choices that were made in the first three steps, we were able to generate 713 clusters.

Assessing Individual Clusters of Candidate Cluster (as star cluster)

Rather than replacing expert judgment with clustering, Clusters (stars), a systematic characterization of individual clusters is achieved through systematic correction of anomalies (stars), thus leading to a finalized definition of Clusters at the end of the process. In order for a region to be able to compete more effectively, it is imperative that it understands the strengths of its clusters. For this comparison to be made, the industry boundaries of each cluster need to be clearly marked with Definitions of clusters that are comparable across regions

3.2.3.Innovation mapping on a regional scale; a case study of the Boston

CLUDS Lab is also has been leading a project to spatialize economic clusters based on local assets, social interactions, and innovation flows developed by CLUDS Lab to understand and develop intelligent, unique strategies for the development of the local economy (MAPS-LED). This project illustrates how innovation works within a region and in more detail at the level of the city where it is happening by mapping innovation at the regional and city level. I firmly believe that the interpretation of Using Porter's model that links innovation, specialization, and job creation within a cluster, this study can be derived from the cluster definition. According to the preliminary research findings, highlighting the spatial usage of the knowledge dynamics' synthesis can Improve cluster performance by coupling cluster performance factors with context characteristics. First, the objective of the first framework is to shape traded clusters by focusing on innovation, while the objective of the second framework is to focus on specialization as the main driving force. This study examined the relationship between trade clusters and Boston's urban fabric, its sociability, and its sustainability using a spatially oriented methodology in order to draw the connection between trade clusters (demand for innovation) and the urban fabric (target areas). In the present study, we looked at how innovation spaces are occurrences in places with a concentration of clusters. As a result of the research activities, it became apparent that EDPs could be used to design policies made for just that area based on the fruitful relationship between knowledge, innovation, and place that was evident throughout the research process. By combining public-private partnerships and innovative financial instruments, urban regeneration mechanisms can be activated in distressed areas, and innovation can be expanded. This study uses MAPS-LED to understand complex and difficult-to-trigger knowledge dynamics at the system level. As explained by the MAPS-LED project, local assets result from discovery processes of entrepreneurship activated by urban policies that aim to regenerate urban areas through knowledge-led processes. Through the development of this methodology, entrepreneurs were able to identify "where entrepreneurial knowledge and forces are active and concentrated, resulting in discoveries." It is cross-sectoral because it can be applied to identify local contexts and knowledge and innovation concentrations.

4. Urban growth or Urban Transformation

Understanding urban change requires conceptualizing the concept of urban transformation. In cities, transformation describes and explains continuous, complex, and contested processes and dynamics. Analyzing these processes provides insight into how they impact urban functions, local needs, and city-environment interactions (Iwaniec et al., 2019; McCormick et al., 2013). According to transformation perspectives, cities must move toward resilient and sustainable urban environments by addressing persistent social, economic, and environmental problems at the systems level (Feltynowski et al., 2018; Hölscher et al., 2019). Sustainability and resilience are used to assess and orient urban transformation processes (Pickett et al., 2014; Elmqvist et al., 2019; Fidino et al., 2021). The idea of an 'urban transformation' has been debated by scientists and policymakers for quite some time now, and it has been gaining popularity. A number of sustainable development goals and sustainable development targets are integrated into UN-Habitat's New Urban Agenda, as well as the Sustainable Development Goals (SDGs) for 2030. The study of urban transformations has drawn from a wide range of scientific disciplines, ontologies, and methods in order to investigate the phenomenon (Elmqvist et al., 2019; Vojnovic, 2014; Wolfram, 2019). Large and small cities are seeking to become more sustainable and resilient, hence the development of urban transformation narratives. A process of urban change is currently underway that does not resemble anything we have ever seen before in the history of cities. Pollution, poverty, and inequality have been among the challenges facing cities in recent years (Bren d'Amour et al., 2017; Delmar & Wiklund, 2008; Haase, 2021). During the process of urbanization, cities alter land use patterns, energy consumption patterns, biodiversity, and lifestyles, resulting in a variety of changes to global environmental indicators, and raising concerns about their role in causing the change in the global environment. For our future to be livable, well-being-oriented, and sustainable, cities are also required to provide the conditions and resources necessary to implement fundamental changes, including transforming energy, transportation, water consumption, land use, housing, consumption, and lifestyles. (Elmqvist et al., 2019; Götz et al., 2016; Romero-Lankao et al., 2018). It is urgent that we understand how cities behave and how they can be better understood as systems that are open, complex, and adaptive. A key component of urban transformation is cross-scale and cross-sectoral dynamics. as this concept argues that urban transformations are not spatially restricted: cities are nodes within a number of Physical, biological, economic, ecological, and political networks that overlap In the continuous flow of people, matter, and information across scales, they are constantly reshaped and reshaped.This subchapter aims to examine what happens when a city system undergoes a transition. We aim to analyze if the cities are in constant growth, if we can find traces of transformation after their growth, and if they are experiencing constant growth. In the past decade, the topic of urban transformation has always been of interest to many people. This is a novel approach to change in the urban system through the lens of a thematic analogy of biological processes to provide a holistic perspective on urban system change. The urban system can be viewed as a biological process, and we are analyzing it as such. Two main aspects of life will be discussed later on in this article. The first step is to convert materials and energies for r the purpose of development and change. The second benefit of having a data bank is that it makes the biological template unique. As seen from the biological perspective, the biological template is called genetics, and the process by which raw materials and energy are converted into development and growth is called metabolism as a result of considering whether endosymbiosis is a theory that can be applied to city systems in order to gain a new perspective. In a sense, we are trying to determine whether or not different life networks, such as economic and social life, are being fed and have any impact on the growth and maturity of the city network. If there is life in even the tiniest city, then the cells from within have feeders similar to mitochondria that convert social and economic elements into a force for growth that can drive the city's growth. In the second part, we analyze the data bank and the unique pattern in each region to see if the city, as a minor element within that pattern, gives a unique shape to the growth template of that region. In order to be able to explain the patterns of genetic strands within a given region, we analyze the genetic strands of each region and present a meaningful visual pattern in order to determine whether it can be possible to present an explainable template through the city, the social, the economic, and innovative distances for a given region. We analyze a city's life through these two parts of the subchapter in order to determine whether it can be considered to be merely a phenomenon with just physical growth or whether it can also be considered a biological phenomenon with life that reaches maturity and can reproduce. It reaches a point after that where it becomes stable, and then it dies from within.

4.2.1. Endosymbiosis theory: life within life to ensure evolution

It was in the year 1960 that Lynn (M. W. Gray, 2017) introduced the concept of endosymbiosis to the world. In other words, it was an evolutionary perspective on life as we know it. There are numerous times when we have used terms such as transition, evolutionary transition, urban system, and complex system in our writings. There are a variety of examples that can be used when discussing terms like these. However, perhaps the most relevant examples are biology-related since biological processes are complete and precise, and their evolution has already been accomplished. Through the use of mechanisms such as natural selection, genetic drift, evolution, and emergence, this evolution is completed through a transition process. As a result of these variables, we are able to gain a better understanding of the complexity of this system-the human species during the history of life, around 2.5 billion years ago. As a result of the metabolic methods needed for the development of single-celled organisms, a process existed by which single-celled organisms lived (Roff, 1993; Gould, 1994; Johnson & Munshi-South, 2017) .

Although they worked hard, despite their efforts, they lived a short and insecure life, despite their diligent work. As a result, they entered cells that were bigger and more stable than their own. With the passing of time, the lives of one organism became dependent on the lives of another organism. This is in such a way that the reproduction of these singular organisms became dependent on the cell that they were engulfed in, and the host cell was dependent on them for the energy and survival that they provided. Two lives that work in conjunction with one another are connected. In contrast to parasitic life, in which the guest utilizes the host's energy for its upkeep, in endosymbiosis, the host provides a safe environment for the guest, and, in return, the guest prepares energy for the host. It is essential to understand that this process has caused an evolutionary process that started with single cells, continued to multicellular ones, and ended with very complex biological systems such as humans or other large mammals. An endosymbiotic relationship explains why a particular part of a cell called the mitochondria exists as a result of this relationship. There are mitochondria in all eukaryotes, which are responsible for the production of protein and RNA, as well as the production of food and energy. There is no doubt that Lynn's endosymbiosis is the best possible explanation for the existence of mitochondria.

Having said that, A city can be viewed as a complex system host with different aspects such as social, economic, environmental, and political, and if we take into account that it is possible to consider the existence of multiple networks in different layers that are described as guests inside this host, utilizing the safety, complexity, and ongoing growth of their host to accomplish their life cycle. In the process of this cycle, wealth is created in the economy, safety and comfort are provided in the city, as well as the completion of governance and governing processes in the environment as a result of this cycle. As a result, if we consider the city network to be like a Eukaryote cell that has different parts, then one of the most critical networks that make up that cell is the economic network. Network analysis can be explained, given numbers, and described in a number of ways, as discussed earlier. There is no doubt that networks can be complex, intertwined, and have significant connections that can all be explained in their own way. Therefore, it is better to say that when we consider an economic network within a city network, it is both a part of the city, part of the main graph, and a sub-graph that can have the ability to create wealth for the development of the city.

One of the most crucial aspects of this discussion is whether or not this growth is a one-way process. Does it follow the same process as the development of cancer? In the alternative, it is a growth that causes embeddedness and therefore produces lines within itself that will form a dynamic process by connecting these lines, which is a growth that produces embeddedness. It has been attempted to describe evolutionary processes in city systems in the following paragraphs. There is a perspective to life known as endosymbiosis, which is the process of putting the economic network in a particular state, enabling it to be dynamic. It is, therefore, possible for the economic network to emerge after many stages of evolution as a result of being this way. In the city network, when an economic network is formed, after some time, there is a convergence for numbers of the members of that network, and they form clusters, which in turn produce competitiveness within the network, as I have previously explained. As clusters grow in competitiveness, they get to the maturity stage when they reach a certain level of maturity. As the city network matures, it also causes the economic network to grow as a result of the maturity that occurs within the city network.

It should also be noted that every time a metabolic process happens within mitochondria, it allows the mitochondria to grow as well as the cell itself to grow. Furthermore, in both the host phenomena and the guest phenomena, it is essential to note that if weakness occurs in either of the phenomena, then the weakness will grow weaker and eventually die. In the event that an economic network is formed within a city and then becomes isolated within itself, it can lead to the network collapse, and when the network collapses, the economic network within the city will also collapse. Those subdivisions that are closer to economic power can grow faster, but the rest of the subdivisions get left behind. The death of a city is referred to as a city that has lower productivity capabilities compare than the living threshold. As a significant part of the work, there is a cemetery that is full of hosts that are unable to make their economic networks endogenous, dynamic, and diverse in order to sustain themselves. Since it considers all the aspects of mitochondria on a local scale, what we describe in theory synchronizations help clarify the gaps in technology, economics, and society on a local level. There is one significant difference between endosymbiosis and theories that propose different layers of parallel phenomenon(M. E. Porter, 1990; Gibbs, 1993; Thinh et al., 2002; Batty et al., 2012) between various parts of city life. Other theories show the dependence of guests on their hosts; in fact, other theories consider each guest part of the system. In the theory we provide, we differ from one another in the manner in which we set different values and effects for different types of networks. Assume for a moment that we are considering the city as a single cell. It is the social and environmental networks that make the cell's life better with higher quality, while the economic system provides wealth and comfort to the cell, which is the power it needs to function. It is the function of the social network to control and maintain the infrastructure of the cell, while the role of the governing network is to reproduce the sound of the cell. As a result, we can conclude that these networks work together as a whole, but their roles differ in some respects. This short subchapter emphasizes the use of the complex system theory as a basis for the outlook we have into the urban regeneration studies. In order to understand a complex system, it is necessary to understand its different components. Neither can it be dissected, nor can it be reduced in any way.

Classical biology divides the biosphere into different organelles according to the way in which they function, whereas evolutionary biology, which has an evolutionary view of city life, views the primary process as one that serves specific purposes, but the boundaries between these parts are unclear. There is a blurring of the boundaries between the components that allow the components to carry out their duties and have complementary effects on the duties of the other components as well. The purpose of this study is to analyze an evolutionary process and apply it to the structure of a city. It is not appropriate to interpret the structure of a city in terms of a set of predefined frames because the structure of a city is part of the life of each member or the entire universe. It is because of this point that we consider different lives within an experience of a host, which is constructed and completed by its guests, and it is their responsibility to ensure its life - the host, in return, supplies the life, reproduction, and security for its guests. For the next subchapter of this thesis a process for experimenting how we can measure the evolution process of an economy by drawing a time series of the economic network within the scope of endosymbiosis has been applying.

Afterward, we will be able to determine if the economy network has been able to have a significant impact on the life cycle (specially the maturity) of the city by the clusters we have set for it or if the city as a part of the region has been able to produce a unique identity with a measurable and analyzable trace that can be attributed to it. The following subchapter discusses the hamming distance technique (Norouzi et al., 2012) to analyzes the space between the cities in a region in Italy (Calabria), presents our findings, and compares them with those based on socio-economic factors that we know about that region in order to draw conclusions. Our analysis was done from a genetic perspective, so we were able to determine if the different organs mentioned earlier could be interpreted from the genetic perspective.

4.2.2.Hamming distance calculation: is economic sectors act as genetic strands?

The primary objective is to answer the question of whether the hamming distance is a valuable tool for comparing nodes within economic network coordination, and if so, this method is general enough to be used in all European Union areas between all local areas so that they can be compared more closely. However, it is essential to note that despite its power and complexity in describing and analyzing complex systems, a network has one weak point: its inability to scale. In previous parts of this research, we introduced different statistical methods to change the qualitative scales of the network to quantitative scales by applying graph theory and statistical analysis as described in the introduction. Hamming distances are used to measure the distance between nodes in a network based on binary rules or weight distances. We computed the hamming distance based on the weight distance in various local areas within the Calabria region according to the existence or non-existence of economic sectors.

We first created a 45 x 399 matrix showing the presence or absence of each sector in local areas using zeros and ones. Then, the distance to the following local area was calculated based on these 399 economic sectors within each local area.

$$\forall\, l_n \in \{l_1,\ldots,l_{45}\};\ \leftrightarrow s_{(1)} \exists\, l_1\ \&\ s_{(1)} \nexists\, l_{(2)} \Rightarrow 1$$

This implies that local area l_1 has a distance of one from local area l_2 if the economic sector s_1 is present in l_1 but absent from l_2. 399 iteration happened between local areas l_1 and l_2, this process applied for all local areas L = (l_1,... ,l_{45}). Finally, we calculated the sum of distances in a matrix of 45 x 45 based on this formula after calculating a matrix containing all the local areas' distances (See Tables 1 and 2).

Then, we used multidimensional mathematical scaling (Tsogo et al., 2000) (MDS) to obtain the a new coordinates of x and y in economic space coordination for local areas. Our knowledge of the distance between local areas l_1 and l_2 enabled us to draw a two-dimensional axis based on multidimensional scaling that showed nodes l_1 to l_{46} in their unique coordinates. The process was repeated for the data of the past eight years (See Table 2).

$$\sum_{\substack{l=1 \\ s=1}}^{\substack{45 \\ 399}} H_{ls}$$

Table1. List of Local LabourMarkets codes

DEN_SLL_2011	SLL_2011	DEN_SLL_2011	SLL_2011
ACRI	1801	BIANCO	1822
AMANTEA	1802	BOVALINO	1823
BELVEDERE MARITTIMO	1803	DELIANUOVA	1824
CARIATI	1804	GIOIA TAURO	1825
CASSANO ALL'IONIO	1805	LOCRI	1826
CASTROVILLARI	1806	MARINA DI GIOIOSA IONICA	1827
CETRARO	1807	MELITO DI PORTO SALVO	1828
CORIGLIANO CALABRO	1808	OPPIDO MAMERTINA	1829
COSENZA	1809	POLISTENA	1830
MORMANNO	1810	REGGIO DI CALABRIA	1831
PAOLA	1811	ROCCELLA IONICA	1832
PRAIA A MARE	1812	ROSARNO	1833
ROSSANO	1813	SANT'EUFEMIA D'ASPROMONTE	1834
SAN GIOVANNI IN FIORE	1814	STILO	1835
SAN MARCO ARGENTANO	1815	TAURIANOVA	1836
SCALEA	1816	CIRÒ MARINA	1837
CATANZARO	1817	CROTONE	1838
CHIARAVALLE CENTRALE	1818	MESORACA	1839
SELLIA MARINA	1819	PETILIA POLICASTRO	1840
SOVERATO	1820	SERRA SAN BRUNO	1841
LAMEZIA TERME	1821	SORIANO CALABRO	1842
		TROPEA	1843
		VIBO VALENTIA	1844

302	1803	1804	1805	1806	1807	1808	1809	1810	1811	1812	1813	1814	1815	1816	1817	1818	1819
51	45	55	55	90	58	80	172	68	56	59	63	55	56	54	132	55	65
0	58	68	62	73	71	79	151	89	55	64	56	74	61	49	107	72	58
58	0	52	54	79	63	85	165	77	47	54	64	60	65	47	121	56	66
68	52	0	66	89	59	99	183	61	69	56	80	42	65	61	145	54	72
62	54	66	0	83	79	77	151	93	61	72	58	74	61	61	117	74	70
73	79	89	83	0	104	74	116	126	70	95	69	99	82	78	86	93	93
71	63	59	79	104	0	104	200	54	70	49	87	51	76	68	158	55	77
79	85	99	77	74	104	0	118	124	78	107	71	101	76	78	92	95	89
151	165	183	151	116	200	118	0	224	150	185	135	193	142	154	88	191	161
89	77	61	93	126	54	124	224	0	88	55	103	51	86	80	176	55	83
55	47	69	61	70	70	78	150	88	0	69	59	67	64	62	110	67	77
64	54	56	72	95	49	107	185	55	69	0	76	54	71	53	143	58	74
56	64	80	58	69	87	71	135	103	59	76	0	80	67	53	99	84	70
74	60	42	74	99	51	101	193	51	67	54	80	0	65	65	147	52	68
61	65	65	61	82	76	76	142	86	64	71	67	65	0	44	114	63	67
49	47	61	61	78	68	78	154	80	62	53	53	65	44	0	112	59	57
107	121	145	117	86	158	92	88	176	110	143	99	147	114	112	0	143	117
72	56	54	74	93	55	95	191	55	67	58	84	52	63	59	143	0	72
58	66	72	70	93	77	89	161	83	77	74	70	68	67	57	117	72	0
66	68	80	64	83	87	83	137	95	69	86	70	82	67	63	89	68	56
121	127	151	115	94	172	102	74	186	124	151	103	159	122	130	74	151	129
69	61	43	67	100	52	108	194	58	58	55	79	45	74	64	146	57	73
69	53	57	63	86	56	90	174	70	64	65	71	59	68	58	130	59	69
92	82	62	98	135	53	137	237	41	91	62	114	56	103	93	189	66	98
85	77	103	81	82	112	74	114	134	76	109	79	109	74	80	90	99	91
70	76	96	76	73	105	79	125	121	77	90	68	96	69	75	81	94	78
59	57	65	61	88	62	84	170	74	58	65	63	61	62	50	126	61	65
69	59	61	65	86	68	92	172	76	64	65	75	65	58	52	128	57	71
90	80	56	96	129	53	129	225	41	89	54	110	54	89	85	179	54	90
66	68	82	70	77	91	83	145	109	61	90	72	82	69	69	103	76	76
128	138	168	128	101	177	91	65	197	125	162	112	168	129	133	77	160	136
57	49	59	65	82	48	84	170	72	54	63	69	57	64	52	124	53	63
65	67	71	69	90	80	84	158	88	68	85	73	79	66	68	118	73	73
93	83	61	99	132	56	136	234	40	92	63	111	55	98	90	186	57	95
82	74	56	88	117	55	125	217	43	81	50	100	54	85	77	171	52	90
64	68	68	64	89	73	87	173	79	65	74	68	68	63	69	131	62	70
66	60	60	62	95	69	93	175	73	65	66	74	52	63	59	133	66	66
109	119	131	111	88	148	90	96	168	116	139	101	139	102	106	86	141	113
90	80	60	98	133	57	137	235	39	95	58	110	52	97	87	187	58	90
72	66	52	78	105	53	103	193	53	75	60	82	44	73	71	153	62	70
82	70	52	76	105	69	117	193	63	73	60	90	60	79	67	153	60	86
83	75	61	87	120	56	120	214	50	82	59	95	53	86	76	170	59	81
70	46	52	64	95	71	97	171	73	67	62	72	68	73	59	129	54	78
99	101	115	99	88	130	86	118	146	98	125	89	123	98	98	90	113	99
102	88	74	108	141	63	145	239	39	101	74	122	66	107	95	193	72	98

Table2 Hamming Distance matrix Calabria region

1827	1828	1829	1830	1831	1832	1833	1834	1835	1836	1837	1838	1839	1840	1841	1842	1843
46	64	73	69	143	56	62	70	61	57	53	124	69	51	69	66	57
59	69	90	66	128	57	65	93	82	64	66	109	90	72	82	83	70
57	59	80	68	138	49	67	83	74	68	60	119	80	66	70	75	46
65	61	56	82	168	59	71	61	56	68	60	131	60	52	52	61	52
61	65	96	70	128	65	69	99	88	64	62	111	98	78	76	87	64
88	86	129	77	101	82	90	132	117	89	95	88	133	105	105	120	95
62	68	53	91	177	48	80	56	55	73	69	148	57	53	69	56	71
84	92	129	83	91	84	84	136	125	87	93	90	137	103	117	120	97
170	172	225	145	65	170	158	234	217	173	175	96	235	193	193	214	171
74	76	41	109	197	72	88	40	43	79	73	168	39	53	63	50	73
58	64	89	61	125	54	68	92	81	65	65	116	95	75	73	82	67
65	65	54	90	162	63	85	63	50	74	66	139	58	60	60	59	62
63	75	110	72	112	69	73	111	100	68	74	101	110	82	90	95	72
61	65	54	82	168	57	79	55	54	68	52	139	52	44	60	53	68
62	58	89	69	129	64	66	98	85	63	63	102	97	73	79	86	73
50	52	85	69	133	52	68	90	77	69	59	106	87	71	67	76	59
126	128	179	103	77	124	118	186	171	131	133	86	187	153	153	170	129
61	57	54	76	160	53	73	57	52	62	66	141	58	62	60	59	54
65	71	90	76	136	63	73	95	90	70	66	113	90	70	86	81	78
71	73	106	70	122	67	75	105	100	86	80	97	106	82	84	97	72
138	138	191	113	67	136	118	196	181	135	137	80	197	159	157	180	137
56	62	51	81	169	56	74	54	47	53	59	144	51	47	45	54	67
54	56	75	77	153	54	70	68	67	67	71	118	69	61	59	62	59
81	81	36	116	210	73	101	27	34	82	84	181	30	58	54	47	78
82	82	133	77	93	88	80	142	131	87	95	90	143	109	113	126	95
73	81	128	70	90	81	87	133	118	78	86	101	134	100	102	115	90
0	54	77	69	137	56	60	80	69	53	63	122	83	57	69	70	67
54	0	77	75	141	56	66	78	67	61	73	126	77	79	65	66	63
77	77	0	108	202	73	89	31	36	72	80	169	42	56	62	41	78
69	75	108	0	118	65	67	117	102	68	82	107	112	90	90	101	80
137	141	202	118	0	147	129	209	192	142	148	93	208	170	170	189	142
56	56	73	65	147	0	70	74	67	67	63	124	75	65	65	68	65
60	66	89	67	129	70	0	98	91	59	79	118	99	77	79	86	81
80	78	31	117	209	74	98	0	39	77	81	178	27	57	57	40	75
69	67	36	102	192	67	91	39	0	74	78	169	40	56	52	47	64
53	61	72	68	142	67	59	77	74	0	70	129	78	68	72	71	80
63	73	80	82	148	63	79	81	78	70	0	117	78	58	70	75	70
122	126	169	107	93	124	118	178	169	129	117	0	175	135	151	158	129
83	77	42	112	208	75	99	27	40	78	78	175	0	48	58	49	74
57	79	56	90	170	65	77	57	56	68	58	135	48	0	58	55	72
69	65	62	90	170	65	79	57	52	72	70	151	58	58	0	59	64
70	66	41	101	189	68	86	40	47	71	75	158	49	55	59	0	77
67	63	78	80	142	65	81	75	64	80	70	129	74	72	64	77	0
100	104	155	101	95	110	100	158	143	119	107	90	157	125	123	142	101
93	79	42	124	216	75	109	37	48	84	84	181	30	66	62	57	86

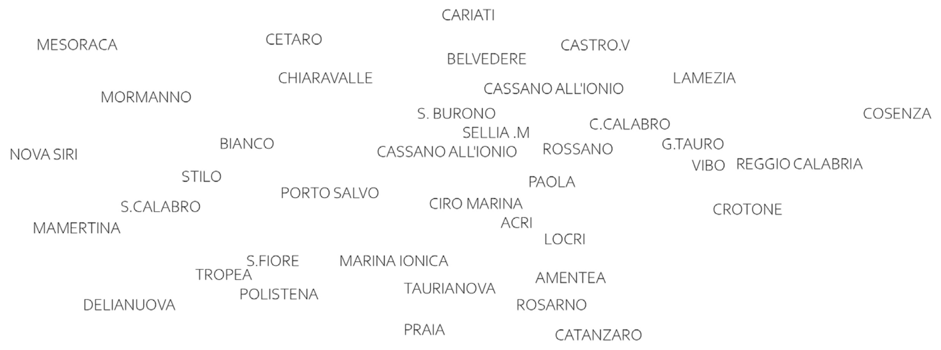

Figure.3 Hamming distance between Calabrian region local areas based on MDS method. 2012

Figure.4 Hamming distance between Calabrian region local areas based on MDS method. 2013

Figure.5 Hamming distance between Calabrian region local areas based on MDS method. 2014

Figure 6. Hamming distance between Calabrian region local areas based on MDS method. 2015

Figure.7 Hamming distance between Calabrian region local areas based on MDS method. 2016

Figure.8 Hamming distance between Calabrian region local areas based on MDS method. 2017

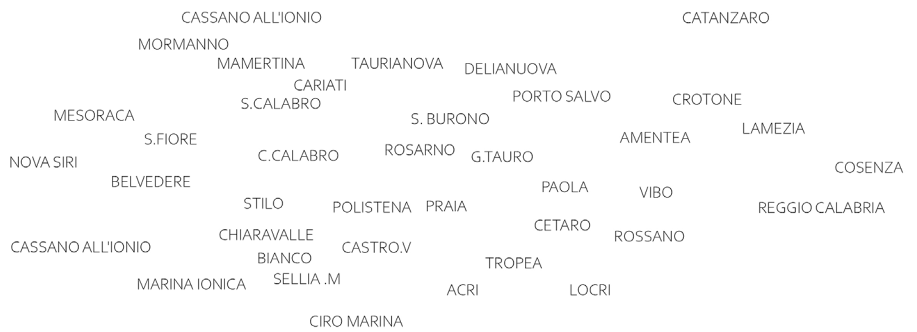

Figure.9 Hamming distance between Calabrian region local areas based on MDS method. 2018

Figure.10 Hamming distance between Calabrian region local areas based on MDS method. 2019

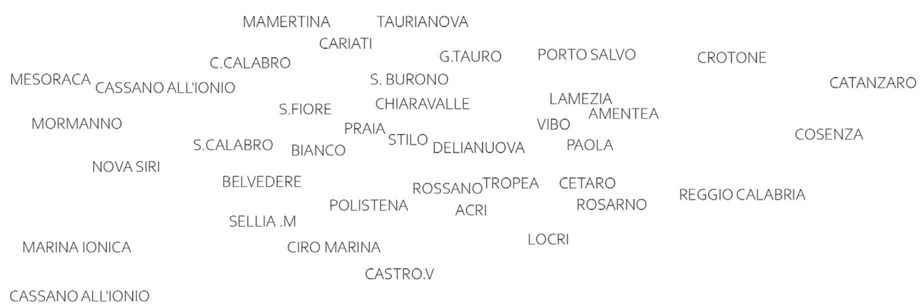

Figure.11 Hamming distance between Calabrian region local areas based on MDS method. 2020

Through experimenting with the ten years that have passed since this system was implemented, we concluded that some local areas that were forerunners ten years ago remained the same, while others dropped back, and some moved forward in their position. Several local areas were regarded as forerunners in the region of Calabria and were regarded as poor performers in the region of Calabria. The Hamming distance scale was able to process local area data on a regional scale to illustrate the most effective local areas for long-term scaling in a complex inter-regional evolutionary process resulting from this outlook. Using this analysis method, it is possible to convert the understanding quality of each node in an economic network of a particular region into a dimensional point on an x and y-axis. Based on a measurable scale for each local area, it can describe the distance between the nods. Communities that have historically been left behind can be compared among different regions of the European Union; in this way, local areas can have coordinates that can be compared on a regional, national or even continental basis.

On a regional scale, the competition between each local area is illustrated. As part of our pre-research, we could illustrate these findings; furthermore, other findings related to the inside of a cluster were also demonstrated. We described a trifold method based on Porter's economic clusters (every cluster has been constituted by six sectors on average). The first step is to report the local areas with the sector intercepts which hosting a higher-than-average number. In other word, each of 45 local areas hosting numbers of economic sectors thus employees, this number is proportional in regional scale. We first find the most employee intensive intercepts which highlights above average local area/sector.

To put it another way, the economic sectors have a larger workforce than the average in each local area and are therefore deemed more labor intensive than the average. In order to analyze this matrix, it was necessary to pay attention to the number 6, which was the average number of economic sectors within each cluster. Therefore, all 45 local areas were analyzed using a frame consisting (this frame is conceptual window for analysis the 399*45 matrix as an stage for sampling) sectors. In the next step, the cells highlighted based on the first rule mentioned in the first step (only cells having more employees than the average) of six economic were identified. This analysis conducted 39*398 permutation to capture the effect of random selection. In addition, a histogram showed the highest number of highlighted cells (See table 11).

5. Conclusion

It was the purpose of this chapter to provide a comprehensive review of literature on network modeling, social network analysis, graph theory and statistics of network studies concerning topics such as network modeling, social network analysis, and graph theory. Ultimately, the goal of this chapter was to provide a comprehensive analysis of the literature in these fields. In a goal to gain a deeper understanding of these networks, we developed a method that can be used to model, visualize, calculate, interpret, and present the results of this analysis in a variety of ways. Various methods can be used to model economic networks, as discussed in the following chapters, and many of them are discussed in the following sections. It is our intention to introduce these networks as clusters with spatial agglomerations so they can be viewed as innovation flows within them as part of our thesis. As a result of Porter's principles, it is possible to determine the types of companies, their direct interactions, and the different interconnections between them as a result of cluster analysis. The purpose of this case study is to demonstrate the effectiveness of innovation mapping through the example of a research project already completed in the CLUDS laboratory in Boston, as a way of demonstrating the effectiveness of innovation mapping. In the context of the MAPSLED project, innovation had already been mapped as part of the project's scope as a part of the MAPSLED project. As you can see from the diagram, there are several points that were shown. On the basis of the fact that the economic network had already been introduced earlier, we have also drawn its innovation path around the economic network. In order to construct this model of the economic and urban network in Calabria, we discussed a research paper that included a case study of this region, which included clusters and networks; statistical data was used to simulate the interconnected nature of the economic and urban networks in the region with the help of this model. This thesis's second part describes a data-driven methodology to build clusters based on the type of data made available. The methodology employs clustering rules as well as networks to assemble clusters based on the type of data available. Through the use of tools which describe and interpret transition phases, we aim to explain and interpret different transition phases. The use of network and cluster analysis tools in this thesis was a key component of illustrating the transition process; by using an innovative concept known as endosymbiosis, we were even able to interpret the transition from a biological perspective. This chapter presented ways that demonstrate the endosymbiotic relationship between the economic network and the complex city network within which it exists.

There has been a noticeable improvement in the performance of certain sectors in certain cities over the past eight years. It has been demonstrated by using this method that the performance of particular sectors on a local and regional level is directly related to the performance of those sectors on a national level. As a result, over the course of this period, certain sectors experienced positive results on a regional level as well. I would like to emphasize the importance of paying attention to 250 average thresholds, which could be characterized as a tendency for polarization among the Calabrian local units as a whole. A ratio of 150 out of 270 (0.55) represents the average highlight rate for the highlighted cells in Table 4. By comparing the average network density (0.35) and this ratio to the results of the Social Network Paper published in this chapter, we will be able to draw some conclusions about the results. Despite this, the numbers are apparently irrelevant, but if we compare this polarization with the highly central network of the Calabria region we observed earlier, we can see that the apparent gap among local units can be addressed by this polarization. There is also the fact that the same local units which play a central role at the level of the network are the ones hosting highly intensive cluster hotspots in the network.

6. Chapter 2 scientific publication

Introduction

After introducing the elements shaping a network, it is possible to use network analysis in the urban domain as a tool to identify the relationship between the city economy and the sustainable development factors of a city. At the end of the second chapter, the author introduced a research paper in which the tool mentioned earlier was used in a regional context by emphasizing local-level outcomes. The question is how it is possible to diagnose the region under the lens of the suggested network to the extent to which urban transition domains are addressed adequately. Since the controllable data was already at hand, Calabria was used for analysis. It was because the researcher's lab was located at a university in Calabria, and there was the possibility of face-to-face relationships with specialists in this domain. This network analysis in the local domain was used and mapped the type of relationship between economic clusters and city places. We could use Porter's theory in the regional economy and big data from national and European databases. We could map two layers of the network, which produced a relationship by shaping the economic transaction, and people transactions between the cities inside a state and making an innovation network. The essay shows the analysis and suggestions of the researcher in the two chapters by using a time series format to show the evolutionary process of this transition by connecting the clusters and city areas. As an urban data analyst, it is crucial for the researcher to know how it is possible to gain growth and stability in a state by increasing the efficiency of each area within and around the city. What was introduced in the research was making a simple platform from a network of complex relationships. This essay takes the initial steps to introduce the elements involved in planning and developing a city. In the following essay, at first, the Calabria and analyzing tool of the research process are introduced; later on, the discussion uses the information stated in the second chapter to guide us to economic clusters and the possibility of forming innovative networks. This short paper is both theories in chapter two and a laboratory to test and analyze the tool introduced. The general relationship of the thesis and using the data infrastructure and mathematical algorithm to introduce citable data be analyzed. In a way, it can be a step by step to introduce new potentials inside a city on the scale of a region. Before starting the essay, what the researcher believes to be the main point of this effort is using a variety of elements to signal out improvable places and places with fragility risks, which in turn prepares for the second stage, the strength process. This stage gives the ability to improve and empowers the regions recognized as vulnerable regions by this algorithm—the result of this paper was published in the MSDPI journal after a peer review session.

Spatializing Social Networking Analysis to Capture Local Innovation Flows towards Inclusive Transition

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Abstract

The location of the local network of firms impacts, positively or negatively, their economic performance. The interactions between different sectors in a territory are still not easily observable. We test the complexity of the economic structure at a local level, given the availability of data at a very granular scale. This could greatly assist in observing sectors or/and locations that play a dominant role in the regional economy. Thus, in order to interpret the economic structure of a territory, we used cluster-based analysis. The analysis helps in evaluating the interconnections among sectors that constitute a cluster. A novel method of describing the territorial economic structure is presented by applying Social Network Analysis (SNA) within cluster-based analysis to characterize the importance of both location and economic interconnections. In this study, we focus on the industrial agglomerations in Calabria, Italy, to underpin the potential of the region's industries by using social networking analysis metrics. This research put forward new interpretations of SNA metrics that describe regional economic compositions. Our findings reveal that territorial social networks are a potential instrument for understanding interactions in regional systems and economic clusters and might help in highlighting local industrial potentials. We believe that this study's results could be considered as the initial steps for a pioneer data-driven place-based structural analysis model.

Keywords: spatial analysis; innovation flows; urban transition; inclusive; clusters; lagging regions; network analysis; data city

Introduction

The economy is a system of individuals and enterprises bound together in markets, policies, laws, public services, and regulations (Balland & Boschma, 2021a, 2021b). As the scale of the world economy continues to grow, the system becomes more complex. In the last decade, studies on economic complexity led to interdependences between the level of income dictated by the complexity of their productive structures and sustained growth, "indicating that development efforts should focus on generating conditions that would allow complexity to emerge in order to generate growth and prosperity"(Hidalgo & Hausmann, 2009). The economic complexity theory and methods have acquired interest within a broader perspective on the global system, whilst sustainability and social inequalities cast light on uncertainties for the future (Balland et al., 2019; Hidalgo, 2021). These complex systems contain unexpected properties and often respond in a nonlinear manner to shocks or changes (Balland & Boschma, 2021b). The systems should self-organize, learn, and adapt to shocks to direct this complexity towards new sustainable trajectories (Loorbach & Rotmans, 2010); in other words, systems should become "resilient" (Balland & Boschma, 2021a; Davoudi et al., 2012, 2013; Hidalgo, 2021). In this paper, we argue that, in order to achieve sustainability and resilience, the system can no longer be "locked into" a particular trajectory of economic development (Garud et al., 2010; Simmie, 2012). Hence, it is argued that new technological pathways that deviate from past practices and attempt to deploy new technologies should be implemented (Balland & Boschma, 2021b). Zivlak et al. claimed that digital services would trigger manufacturing firms to enhance their servitization processes and increase their competitiveness and performance (Ardolino et al., 2018; Martín-Peña et al., 2019). However, the digital divide renders people and places unequal regarding teleworking, and many cities have initially provided measures to reduce gaps. During the COVID-19 pandemic, digitalization has pushed many cities to systematize the use of smart tools more permanently (Hassankhani et al., 2021). For instance, remote patient monitoring devices (Vegesna et al., 2017) and drones were employed to disinfect locations (Hassankhani et al., 2021). These tools and the changes in habits they entail will remain as permanent components of a city's recovery phase and increase preparedness for any future shocks (Cities Policy Responses - OECD, 2016) . However, lagging regions lack technological capabilities to access essential services and economic opportunities. The development of sustainable technological change introduces different challenges (Söderholm, 2020)and that need to be properly understood by policy makers and professionals at different levels in society. We also identify some avenues for future research. The discussions center on five challenges: (a, which correlate with the context concerning the innovation system's level of preparedness (Pita et al., 2021). These conditions, in turn, reflect the inclusive character that sustainable transition requires to avoid the drawbacks of new capitalism (Conca & Dabelko, 2019) that can increase inequalities and exclusion (Iammarino et al., 2019). Pinheiro et al. claimed that the constraints and opportunities of regions to move to more complex innovation and industrial systems are based on the following: (i) the region's income levels, (ii) the level of the complexity levels, (iii) population density, and (iv) whether the regions belong to old or new EU member states (Pinheiro et al., 2022).

We aim to investigate the level of complexity of the local economic structure within lagging regions. The transition begins and occurs at the local level (Geels & Schot, 2007; Martinez, 2009; Eraydin, 2013). The combination of city-level decision making, local stakeholder engagement, and dense populations means that these types of settings can provide ideal testbeds in which innovations are aimed at enhancing sustainable growth and inclusive growth can be piloted (European Commission. Joint Research Centre., 2020). Thus, we adapt the concept of granularity in our study to observe, in detail, the pieces of the economic structure that a region can take as a basis for smart specialization (Dominique & Xabier, 2013). Specifically, our research question is the following: how can the local competitive potential of lagging regions be measured? The question is tackled by analysing industry agglomeration and the industry's interconnection in the Local Labour Market Areas (LMAs) in one of the lagging regions in Southern Italy: Calabria. We focus on industry agglomeration and firm clustering identified by Porter (Porter, 1990). Cluster-based analysis is a tool for obtaining an improved and deeper understanding of the regional economy. It allows the interpretation of the economic structure of a territory according to the interconnections among sectors that constitute a cluster (Maskell, 2017). Social Network Analysis (SNA) is applied to understand the cluster's structure and to trace complexity within the region. Investigating the interconnections inside each cluster could help pave a path for transition. We formed a network by considering economic sectors within a cluster in a specific territory as nodes. We aim to identify the flow of knowledge in a broader sense by examining benefiting employees participate in the same cluster or establishments in the same cluster as a proxy of interaction. Consequently, in line with the cross-sectorial perspective, we investigate whole-system benefits by using SNA within the cluster-based analysis to obtain an overall picture of regions' networks.

The case study is a European region with long-lasting structural development and growth issues. The paper is articulated as follows. First, we start with cluster-based analysis and SNA. In this manner, the theoretical background of network studies, network analysis, and SNA metrics will be considered. Then, two perspectives of "space of place" and "space of flow" will be introduced as the root for spatial studies. Connecting the mentioned concepts helps render reasoning a tool for measuring complex issues at the urban level with respect to spatial economic network necessity. After forming the theoretical framework for a novel networking analysis tool approach, this paper's methodology will be presented. We will precisely explain the spatial unit of study in the Calabria region in Southern Italy. To analyse the case, we investigate data in three interconnected layers. First, we examine the region's economic composition. Second, we examine the point under the lens of a particular cluster to observe if there is a meaningful pattern for couplings. Finally, we verify the system's results in diversification; the so-called Emerging Industries will be demonstrated in a multimode network.

2. Overview of Cluster-Based Analysis and Social Network Analysis

Industry agglomeration has been helping in understanding how and why firms group within specific sectors (Malmberg & Maskell, 1997). A set of clustering algorithms was implemented to generate a set of cluster definitions. The definitions are based on inter-industry linkages based on the co-location patterns of employment and establishments, input–output linkages, and shared labour occupations (Delgado et al., 2016). In 1990, Porter identified the reason behind firm clustering and its importance. He introduced the concept of clusters as "geographic concentrations of industries related by knowledge, skills, inputs, demand, and/or other linkages" (Delgado et al., 2016). Porter summarized that clusters have a broad impact on competition (Porter, 1990). It helps increase firms' productivity based in the cluster by driving innovation and its pace, reinforcing productivity growth.

Moreover, it stimulates new business, expanding and empowering the cluster (Porter, 1998). Clusters "have powerful roles in the diagnostics design and delivery of effective policies to contribute to the number one objective of achieving more jobs, growth, and investments" (Knight, 2021). The economic relationships that emerge within clusters create a competitive advantage for the firms in a specific region (Tallman et al., 2004). Then, this advantage becomes a temptation for investors and suppliers of those industries to develop or relocate to that region (Hill & Brennan, 2000). Therefore, developing industrial clusters has become critical to regional and economic development planning, strategies, and policies (Nolan et al., 2011). An increasing number of regions worldwide have modified their economic development strategies to focus more on and capitalize on industrial clusters where they wish a competitive advantage (Development, 2006). Over time, regions with cluster portfolios have proved to be innovative leaders, while it was proved that regions with no clusters are still behind (Bordei & others, 2016). Porter identified 67 clusters, and they are divided into two categories: "traded" and "local" clusters, with 51 and 16 clusters, respectively (Nolan et al., 2011). The European Cluster Observatory encompasses the structure of 51 clusters in the European context as a critical dimension of the current policy agenda. This paper focuses on the 51 traded clusters, their performance, and relationships within the case study region. The traded clusters are the clusters "that concentrate in particular regions but sell products or services across regions and countries" (Delgado et al., 2014). They empower the region's resistance by three main properties: (i) clusters enhance the region's specialization and therefore its productivity, (ii) dynamic clusters tend to easily deal with shocks through their ability to transfer capacity into new market fields, and (iii) regions with clusters have many interconnections and overlaps that boost their diversification and specialization (Bordei & others, 2016). This state of complexity is the primary source of growth in the region.

Clusters provide a fertile ground to promote industry transformation and the development of emerging industries (Knight, 2021). From here comes another study on emerging industries carried out in this article. The European Cluster Observatory identified that emerging industries face megatrends (Izsak et al., 2016). Emerging industries can be understood as either new industrial sectors that are emerging or existing industrial sectors that are evolving or merging into new industries (European Observatory for Clusters and Industrial Change, 2018.). Emerging industries often have high growth rates and further market potential, essential for future competitiveness and prosperity (Tajani & Hahn, 2012). In the latest document published by the European Cluster Panorama, it was highlighted that the collaboration between business, research, and government within and between clusters is helping to build a robust recovery plan during the COVID-19 pandemic in regions across Europe (Knight, 2021).

This paper seeks to address the sectors' interconnections by applying network analysis to cluster spatialization. Networks have been an essential tool for understanding regional economics and economic geography (Chang et al., 2014). They allow for understanding direct and indirect linkages that are part of an economic system. They also allow for understanding the interaction between firms and markets (O'Donoghue & Gleave, 2004). Network analysis has recently advanced in economic geography and regional sciences (Cassi et al., 2012; Glückler & Doreian, 2016), but it is still developing (Searle et al., 2018). The network can itself be described in terms of its node sizes (which in our study indicate the size of the industry in the region), density (proportion of interconnections between sectors) (Wasserman & Faust, 1994), centrality (the extent to which the network revolves around any single node) (Freeman, 1978), closeness (the role of proximity for on innovation) (R. Boschma, 2005), and betweenness centrality (the impact of some nodes in "transforming" the knowledge) (Freeman, 1977) (Table 4). Interest in cluster research and network analysis has expanded in recent years (Giuliani & Bell, 2005; Glückler, 2007; Morrison, 2008; Ter Wal & Boschma, 2009), evident from burgeoning academic literature. For example, some articles have applied social networks to study the evolution of firms within clusters (Wasserman & Faust, 1994; Freeman, 1977, 1978; R. Boschma, 2005; Giuliani & Bell, 2005; Glückler, 2007; Morrison, 2008; Ter

Wal & Boschma, 2009; Searle et al., 2018; Alberti et al., 2021), assessing the connectivity of the urban system through spatial connections of clusters by network analysis visualization tools (Bevilacqua et al., 2022), investigating the impact of economic crisis by using the SNA to (Falcone et al., 2018) the regions' structural understanding via networks (Taylor & Derudder, 2015; Zhang et al., 2020), and the influence of spatial proximity on the knowledge flow (Huggins & Johnston, 2010; Lopolito et al., 2022). However, the aspect of adding the location into the social network has still not been widely tackled.

In the economic geography debate, there was a question of which is more relevant for the competitiveness of firms: the places or the networks (Beije & Groenewegen, 1992). The concepts of "space of places" and "space of flows" are both crucial when it comes to cluster analysis (R. A. Boschma & Ter Wal, 2007). The idea of "space of places" expresses that location matters for learning and innovation (Lentini & Decortis, 2010). In addition to this, the concept of "space of flows" highlights the role of networks as the necessary form for transferring and diffusing knowledge (Castells, 1999). Therefore, it is essential to underpin and visualize the clusters' network and then contextualize the flow to investigate the location's role in creating the whole system. In this study, we not only generate industry networks that only reveal flows of inputs and outputs between firms, but we added a special dimension to the network to identify and anticipate locations' impact on the industry. We focus on territorial social networking analysis, as the cluster literature has claimed that regions are drivers of innovation and economic development (Montana et al., 2001). Firms in groups benefit automatically from knowledge externalities through labour mobility, informal networks, buyer–supplier relationships or R&D cooperation (Marshall, 1898). This is because tacit knowledge moves easier across short distances, and shared institutions at the cluster level facilitate the effective transfer of knowledge (Marshall & Marshall, 1920). Within the region, we shed light on Local Labour Market Areas (LMAs) (Figure 1) as the spatial unit and the intra-regional development unit of analysis.

Figure 12
Calabria region
Local Labor
Market Areas
(LMAs)

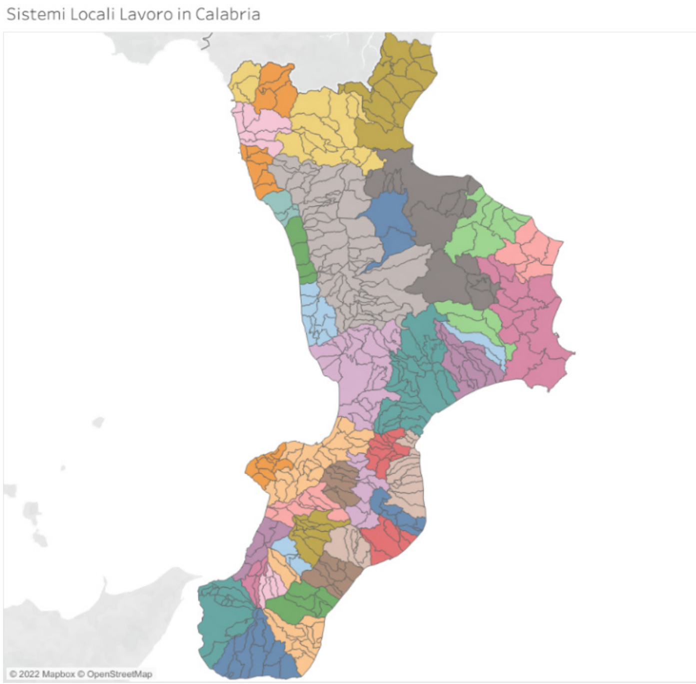


Figure 12. Calabria region Local Labour Market Areas (LMAs). Source: http://osservatoriosviluppolocale.regione.calabria.it/web/sll-calabria-aggiornamento-2021/ (28/02/2022).

To be more precise, LMAs started when the American concept of Standard Metropolitan Areas was introduced (J. M. Casado-Díaz, 2000). This attempted to describe the pattern of people's activity within an urban area based on their work trips. In other words, LMAs are based on a territorial unit whose boundaries, regardless of the administrative organization of the territory, are determined using the flows of daily home/work trips (commuting) (Suedekum et al., 2014). The LMA concept has been widely used for administrative and research purposes and has been successfully applied in Italy (Rangone, 2002). Furthermore, LMAs are crucial to understanding the performance of the labour markets and one of its distinct constituent elements (J. M. Casado-Díaz, 2000). They represent the local labour pool in which the transfer of knowledge and technology is easy between firms (Marshall, 1898; Marshall & Marshall, 1920; Beije & Groenewegen, 1992; Castells, 1999; J. M. Casado-Díaz, 2000; Montana et al., 2001; Rangone, 2002; J. Casado-Díaz, 2007; R. A. Boschma & Ter Wal, 2007; Lentini & Decortis, 2010; Huggins & Johnston, 2010; Suedekum et al., 2014; Zhang et al., 2020; Lopolito et al., 2022).

In this study, we apply spatial coordination with SNA to data in 2019 for industrial clusters in Calabria, Italy, to investigate the importance of social network and spatial location in exploring the complexity level within the cluster-based analysis.

Domain	Characteristics	Annotation	Definition	Equation	Note
Node	Degree	d_v	the degree d_v of a vertex or node v, in a network graph G = (V,E) counts number of edges in E incident upon v.	$\{d_1,\ldots,d_{N_v}\}$	Degree varies among Direct and Undirect networks based on In/Out degree distinction.
Node and Network	Closeness Centrality	C_{Cl}	The standard approach lets the centrality vary inversely with a measurement of the total distance of a vertex from all others where dist.(v,u) is the geodesic distance between the vertices u,v $\in$ V.	$C_{Cl} = 1/\sum_{u \in V} dist(v,u)$	Often, for comparison across graphs and with other centrality measures, this measure is normalized to lie in the interval [0,1].
Node and Network	Eigenvector centrality	C_{Ei}	This definition of centrality seeks to capture the idea that the more central the vertex's neighbourhood is, the more central the vertex itself is.	$c_{Ei}(v) = \propto \sum_{\{u,v\} \in E} cEi(u).$	The convention is to report the absolute values of these entries, which will automatically lie between 0 and 1 by orthonormality of eigenvector.
Network	Degree Distributions	f_d	Given a graph G, define fd as the fraction of vertices v $\in$ V with degree dv = d. The collection {fd}d $\geq$0 is called degree of distribution of G and is simply the histogram formed from the degree sequence, with bins of size one, centred on non-negative integer.	$\{f_d\}_d \geq 0$	The degree distribution provides a natural summary of the connectivity in the graph. In practice, degree distribution is arguably interesting as descriptors for large graphs.
Network	Density	den(G)	Cliques are subsets of fully cohesive vertices in the sense that edges connect all vertices within the subset.	$den(H) = \frac{\lvert EH \rvert}{\lvert VH \rvert(\lvert VH \rvert - 1)/2}$	The value of den(H) will lie between zero and one and provides a measure of how close H is to be a clique.

Table 4
Descriptive analysis of Network graph characteristics

3. Methodology

3.1. Area of Study

Our case study is the Calabria region in southern Italy. Calabria is one of the EU's least developed regions, with Gross Domestic Product (GDP) at about 60% of the EU av-erage and unemployment at around 20%. Moreover, its population is small, at only about 1,860,601 inhabitants in 2021. Calabria is a statistics NUT III Region and integrates 5 provinces (NUTS III), Catanza-ro, Cosenza, Crotone, Reggio di Calabria, and Vibo Valentia, that contain 45 LMAs (Figure 1). Table 2 shows the LMAs' populations, which influen-ce the results. COVID-19 has substantially impacted the regional economy, drastically re-ducing the turnover of small and medium-sized private en-terprises that represent 97% of regional configuration. Additionally, tourist flows at regional accommodation establish-ments have suffered a sharp fall after years of growth. According to data from the Tourism Observatory of the Calabria Region, attendance in 2020 decreased by more than 50%. Looking ahead, the regional economy could draw impetus from public programs launched in response to the pandemic crisis, including in particular the National Recov-ery and Resilience Plan, especially if these manage to aid with the delays affecting the Ca-labrian production system, with regard, for example, to the provision of infrastructures and the levels of digitization (Kolaczyk & Csárdi, 2014).

Table 5
Local Labour Market Areas' population in 2019

LMA	Population in Thousands	LMA	Population in Thousands
Acri	22.9	Gioia Tauro	58.9
Amantea	27.5	Locri	38.6
Belvedere Marittimo	21.9	Marina Di Gioiosa Ionica	20.3
Cariati	17.7	Melito Di Porto Salvo	34.2
Cassano All'ionio	49.3	Oppido Mamertina	7.2
Castrovillari	59.9	Polistena	43.5
Cetraro	13.7	Reggio Di Calabria	215.0
Cosenza	259.3	Roccella Ionica	18.2
Mormanno	16.7	Rosarno	29.2
Paola	31.3	Sant'eufemia D'aspromonte	7.4
Praia A Mare	13.5	Stilo	8.7
San Giovanni In Fiore	21.6	Taurianova	18.3
San Marco Argentano	30.7	Cirò Marina	25.8
Scalea	25.5	Crotone	119.0
Catanzaro	146.9	Mesoraca	6.6
Chiaravalle Centrale	14.8	Petilia Policastro	17.6
Sellia Marina	29.4	Serra San Bruno	15.1
Soverato	41.4	Soriano Calabro	12.5
Lamezia Terme	130.4	Tropea	22.2
Bianco	15.4	Vibo Valentia	101.9
Bovalino	26.2	Corigliano-Rossano	99.4
Delianuova	5.8	Nova Siri	13.7

3.2. Methods and Materials

In order to investigate the economic structure in Calabria that is dealing with a sus-tainable transition and its complexity, we have implemented a merged methodology by spatializing SNA metrics at the territorial level. In this way, we benefit from cluster-based analysis to illustrate the region's economic structure from a novel perspective. In the first step, we aimed at picturing the region's industries under the lens of cluster-based analysis to interpret the economic structure of LMAs according to the interconnections among sec-tors that constitute a cluster. This first step was carried

out through the economic sectors aggregated into 51 clusters and the territorial unit over the case study area. In the next step, we spatialized clusters using the SNA tool to highlight the clusters' compositions. Finally, we used SNA as a practical tool to define how the interactions of sectors form the economic structures.
Moreover, it has a set of analytical features that analyses those interactions within a network of nodes (actors) and ties (relationships). In the next subchapters, we will detail different levels of industries' agglomeration and the network structure aligned with the research perspective. In essence, this paper performs a sequential analysis of the cluster network of Calabria to reveal its undiscovered aspects of complexity.

3.2.1. Forming Territorial Social Networking (TSN) of Calabria Region

Forming a data frame is an essential stage in conducting this experiment. To respond to this requirement, we extracted the economic data (number of establishments and labour force in those establishments) from the Italian National Institute of Statistics (ISTAT). To be more precise and follow the research line of reasoning, first, we aggregated the city-level data to LMAs based on their geographic distribution over the Calabria region. LMAs are territorial units blurring the administrative boundaries of a city to include its surround-ings where the labour moves and knowledge flows. Thus, Calabria's 45 LMAs are placed as the vertical axis of the data frame. Next, the clusters' data are aggregated based on the LMAs. Both the number of establishments and the number of employees of each economic sector (399 sectors) are utilized for each year; in this way, the horizontal axis of the data frame is formed. Finally, the data frame for all years for the 51 clusters is elaborated (Table 6).

Cluster Name		
Selection Period	Year (2012–2019)	
NUTS Level **ISTAT (National Census Bureau)** **Italia (NUT 1).** **Region (NUT 2)** **Municipality (NUT 3)**	Number of Establishment NACE 4 digits per cluster and LMA	Number of Employees NACE 4 digits per cluster and LMA
ATECO Code (2007)	Sectors NACE 4-digit aggregation based on Traded Cluster and Emerging Industries	
Italy **Southern Italy** **Calabria** **LMAs**		

Table 6
The data framework of the case study

The next step is data preparation for spatial networking analysis. This level consists of extreme detection, data validation and data frame transfer to create an adjacency matrix (A). .

Table 7
LMA and Sectors Adjacency Matrix

Sectors	1801	1802	.	.	.	1845
510	1	1	.	.	.	0
610	1	0	.	.	.	0
620	0	1	.	.	.	1
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
9329	0	0	.	.	.	0

At this step of the experiment, connections of the regional network are being investigated. We tried to draw a big picture of the structure by testing the adjacency matrix to understand the network statistics. Table 7 illustrates the LMAs' connection probability, which relies on transforming the adjacency matrix to a logical incidence matrix (Ai) as:

$$\forall a_{ij} \in A \rightarrow a'_{ij}=0 \leftrightarrow a_{ij}=1$$

To develop a comprehensive network, we checked all anomalies and extremes of the data frame. To some extent, the data were precise, but some cities belonged to overlapping LMAs or experienced the sudden shutdown of an industry in a specific year and reopening in further years, where the issues require special attention and we must avoid relying solely upon automatic algorithm development. To elaborate the matrix, two forms of connection are taken into consideration. On the one hand, we investigated whether the nodes (v) are connected into a network and then evaluated the network total size (total of vertex pairs). On the other hand, we calculated the node's degree, network diameter, network density and traditional networking analysis metrics such as centrality (Jackson, 2010). The following algorithms are conducted to form an interpreted, visualized, and robust structure. Force Atlas 2 (Jacomy et al., 2014) is a force-directed layout: it simulates a physical system to specialize a network. Nodes repulse each other like charged particles, while the edges attract nodes like springs. These forces create a movement that converges to a balanced state. This final configuration is expected to help interpret the data (Jackson, 2008). Though it may require some adjustment, the Fruchterman–Reingold (Tunkelang et al., 1999) layout works well for many large social networks. The algorithm uses an iterative process to adjust the placement of the vertices to minimize the system's fluctuations. Due to the iterative nature of this layout, it runs repeatedly, each time incrementally changing the position of each vertex based on the last part.

3.2.2. Random Sampling TSN in Calabria

At this stage, we wanted to take a more advanced step by locating the LMAs in the network. Therefore, we retrieved their geographical coordinates from ISTAT thanks to the software (Gephi™) (Bastian et al., 2009) that handled the visualization of the economic structure with respect to geo-located LMAs in a reasonable time. In the first stage of forming the network, we randomly selected 8 clusters in different sizes to analyse the connectivity for 2019. Then, to enumerate the connection weights, we relied on the reported number of employees and establishments and replicated the links and the node sizes based on mentioned numbers. Subsequently, to import the matrix into the software, we considered the numbers (matrix digits) as string data types due to the average commuter from LMA X to sector Y. These numbers are imported by one decimal. The connections are considered indirect since the relationship between two nodes is regarded as coincident in the conceptual TSNA system and has no priority. The Geo layout algorithm was applied to connect LMA nodes to their geographic position in this network. The nodes were partitioned by their relative degree (number of connections). The connectivity was investigated and demonstrated by the line weight. The economic sectors and LMAs were divided by colour.

3.2.3. Education and Knowledge Creation Cluster TSN and Blue Growth TSN in Calabria

The data collection to constitute the 51 clusters within the Calabria regional context, together with the ten emerging industries, allows for configuring the granularity performance according to the rationale behind the cluster-based analysis concerning the changes over the observation period of 2012–2019. As the first result of the proposed methodology, we show the potential of the territorial SNA applied for the education and knowledge creation cluster and Blue Growth emerging industries in the last update year, 2019. Furthermore, the network density as a general characteristic of the graph (Nešetril & Ossona de Mendez, 2010), the degree distribution of the nodes as the level of beneficiation of the network, and the eigenvector centrality (Kolaczyk & Csárdi, 2014) are calculated and stored in an elaborated data frame. The next chapter will detail the particular findings in the complex network elaborated based on the abovementioned data frame.
The cluster and the emerging industry selected to display how the TSNA methodology operates can provide grounds for reasoning on the industrial change claimed to accelerate industrial modernization towards a sustainable transition. Tables 5 and 6 contain the specific sectors aggregated for the "Education and knowledge creation" cluster and Blue Growth emerging industry, respectively.

Table 8
Education and knowledge creation cluster sectors

Cluster	NACE	Industry Name
Education and knowledge creation	72.11	Research and experimental development on biotechnology
	72.19	Other research and experimental development on natural sciences and engineering
	72.20	Research and experimental development on social sciences and humanities
	85.41	Post-secondary non-tertiary education
	85.42	Tertiary education
	85.52	Cultural education
	85.59	Other education n.e.c.
	85.60	Educational support activities
	94.12	Activities of professional membership organisations

Emerging Industry	NACE	NACE Name
Blue growth industries	03.11	Marine fishing
	03.12	Freshwater fishing
	09.10	Support activities for petroleum and natural gas extraction
	10.20	Processing and preserving of fish, crustaceans and molluscs
	22.19	Manufacture of other rubber products
	25.99	Manufacture of other fabricated metal products n.e.c.
	28.11	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
	28.22	Manufacture of lifting and handling equipment
	30.11	Building of ships and floating structures
	30.12	Building of pleasure and sporting boats
	33.15	Repair and maintenance of ships and boats
	35.11	Production of electricity
	35.12	Transmission of electricity
	36.00	Water collection, treatment and supply
	42.91	Construction of water projects
	46.14	Agents involved in the sale of machinery, industrial equipment, ships and aircraft
	49.41	Freight transport by road
	50.10	Sea and coastal passenger water transport
	50.20	Sea and coastal freight water transport
	50.30	Inland passenger water transport
	50.40	Inland freight water transport
	52.10	Warehousing and storage
	52.22	Service activities incidental to water transportation
	52.23	Service activities incidental to air transportation
	52.24	Cargo handling
	52.29	Other transportation support activities
	71.12	Engineering activities and related technical consultancy
	71.20	Technical testing and analysis
	72.19	Other research and experimental development on natural sciences and engineering
	73.11	Advertising agencies
	77.32	Renting and leasing of construction and civil engineering machinery and equipment
	77.34	Renting and leasing of water transport equipment
	79.11	Travel agency activities

4. Results and Discussion

4.1. Forming Territorial Social Networking Analysis (TSNA)

This chapter presents the findings of TSNA results from four perspectives. First, the outcome of the investigation in Calabria as a single territorial dimension hosting all 399 sectors of 51 clusters will be explained. Graph (figure 2) consists of nodes (two modes): (i) LMA as a spatial dimension and (ii) sectors of clusters (four digits) and ties as links between territorial units and economic sectors that form the economic structure. In this view, we look over the small granularity level of the network to capture the complexity of economic structure in terms of which economic sectors are influencing the structure and provide significant potential for change. The European observatory of clusters classified 399 industrial sectors. However, Figure 12 shows that only 358 sectors exist in Calabria. This could be interpreted as a 10% lack in economic sectors in traded clusters. Moreover, A total of 21 LMAs out of 45 have less than 10% connectivity, which can explain the lagging performance of the region (Figure 13). We then report network density; Figure 15a shows the left skewness in the degree distribution, which means a few sectors are dominant. Furthermore, the same pattern in the eigenvector centrality shows the tendency of the dominant nodes to connect each other (Figure 15b). The structure is sparse. There are (358 × 45) 16110 records; among them, less than 16% non-zero pairs found.

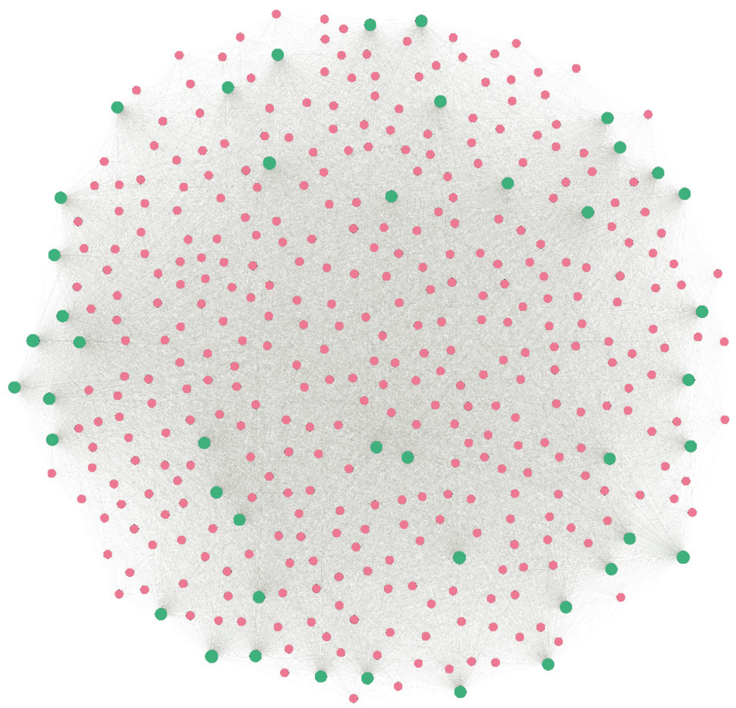


Figure 13. TSNA of all sectors in Calabria in 2019. Pink nodes = sectors, and green nodes = LMAs.

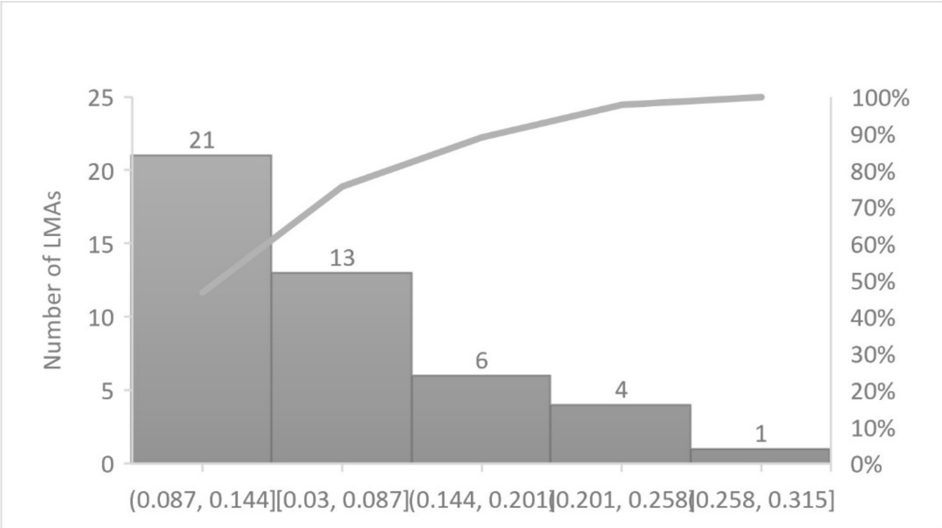


Figure 14. Connection probability chart of inverse network (Calabria region).

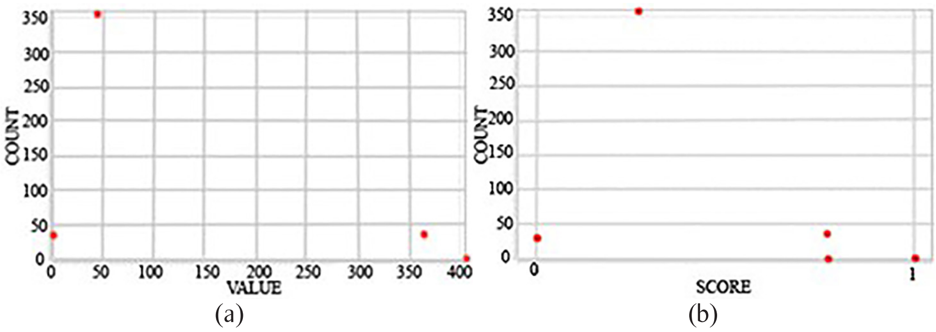


Figure 15. (a) Degree distribution and (b) eigenvector centrality distribution..

4.2. Random Sampling TSNA in Calabria

In this experiment, the green nodes' (the clusters) sizes are proportional to the number of establishments. In other words, it is the size of the cluster in the region—the line weight advocates the cluster's number of establishments in the connected LMAs. As expected, although the well-known LMAs (Cosenza and Reggio Calabria) are engaged proportionally to their influential position, this model highlights that other medium-size LMAs are playing relatively positive roles. Lamezia Terme, Catanzaro, Vibo Valentia, Crotone, and Castrovillari establish reliable connections to the region's main active clusters, respectively (Figure 16). The degree of distribution (Figure 17a) highlights that there is a large number of LMAs with less than 12 connections (meaning less than 0.01% of the possible number of links). As a result, there is a geographical disparity in which these dominant LMAs mentioned earlier absorb a significant number of opportunities. The sparsity of the network due to its low density (20%) demonstrates the weakness of the economic structure.

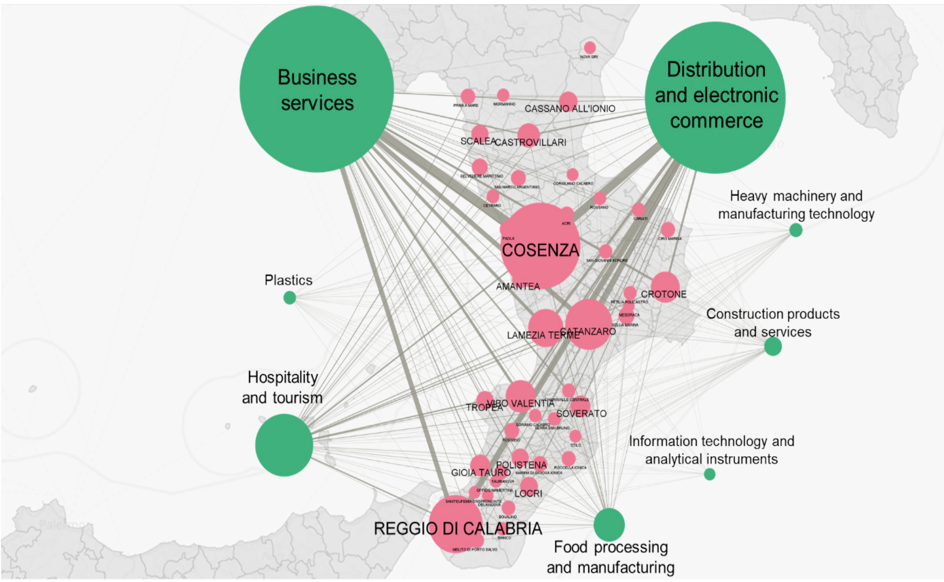
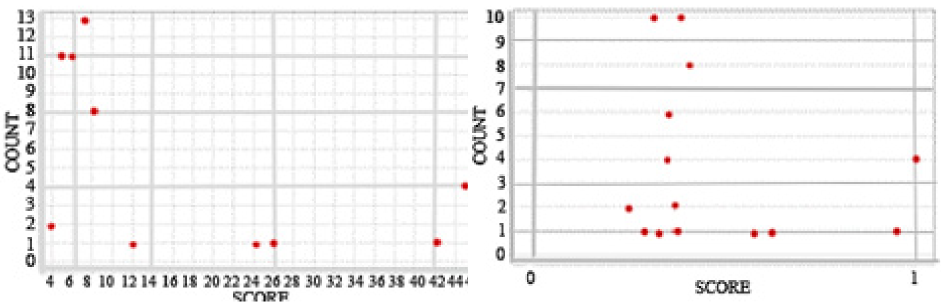


Figure 16. TSNA of 8 clusters in Calabria in 2019

Pink nodes = LMAs and green nodes = clusters. The LMA node size reflects the total number of units in all clusters found in that LMA. Whereas the cluster's node size is the aggregated number of units in that cluster. Edge's width is no. units in each sector in the connected LMA.



(a) (b)

Figure 17 (a) Degree distribution and (b) eigenvector centrality distribution.

Clusters are not evenly facilitated due to local resources, scarcities, and possible missings knowledge diffusion. As Figure 16 shows, the "Business Services" cluster and "Distribution and electronic commerce" cluster are considered two of Calabria's most important clusters. Still, it is essential to name the "Hospitality and Tourism" cluster as a well-functioning economic potential of the territory. This cluster can be found in all 45 LMAs. The same goes for the "Food processing and manufacturing" cluster. This cluster hosts a small number of establishments, but due to a high degree of connectivity of 100%, it pays an immense contribution to regional resiliency. On the other side, the "Information Technology and Analytical instruments" cluster shows a low connection. This lag can be described in the digitalization phase, where the accommodation, advertisement and quality auditing services are radically changed. We want to emphasize that the size is not the only important aspect, but also a high degree of connection in a sparse network can enhance the territorial resilience (see Figure 17b).

4.3. TSNA Education and Knowledge Creation Cluster

This study's first level (intra-cluster perspective) observes a network of 45 interactive geo-coordinated nodes highlighted in red, while nine of the "Education and creation" cluster sectors are illustrated in green (Figure 18). At first glance, it is essential to mention that the network formation's core/periphery nature is evident in both levels. It is clearly shown that the critical LMAs play a significant role in the education knowledge diffusion, while the small share of the others is neglectable. More in detail, we can mention the degree of connection between "Other Education n.e.c.", which primarily relies on the private universities and training centres and the two main hubs of the Calabria region (Cosenza and Reggio Calabria). At this stage, the degree of distribution is commonly proportional to the number of establishments, as 250 establishments were allocated to the "Other Education n.e.c." and considered 65% of the network density. Other highlights are that 13 LMAs out of 45 primarily (more than 70%) rely on the same sector to connect the network. Surprisingly, an LMA, CARIATI, is entirely isolated (has 0 connection). To be more precise, we can group the territory into two vividly separated subsets where the Cosenza and Reggio Calabria are the primary hosts of the Calabrian education centres while the rest have a low connection. The observed situation in this cluster demonstrates the low level of complexity due to the low network density (less than 10%) in the region according to knowledge infrastructures in a way that can be interpreted as a call for particular attention to reinforcing the small-scale cities for hosting education facilities (Figure 19 a, 19b).

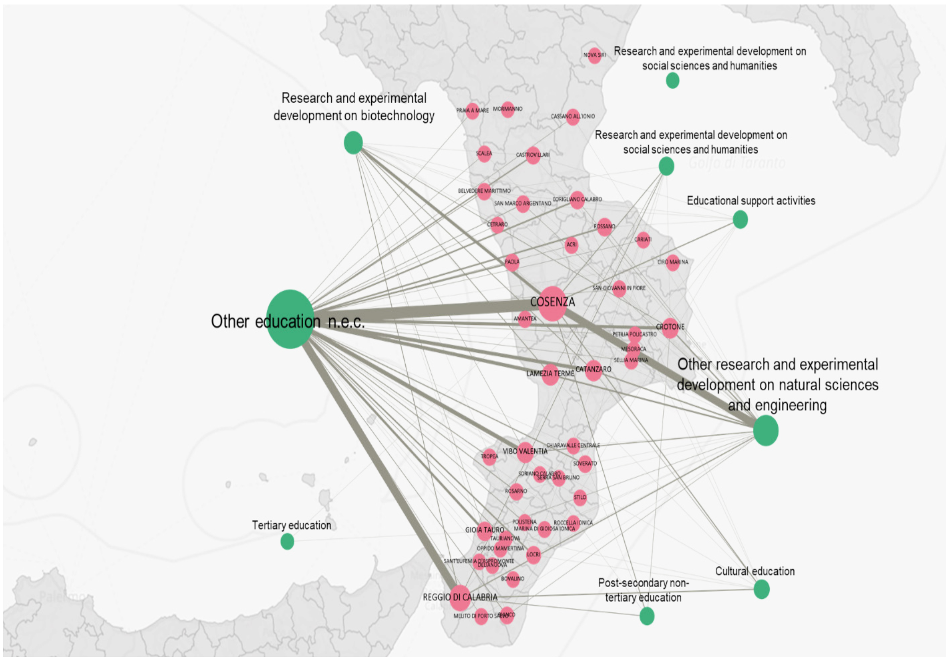
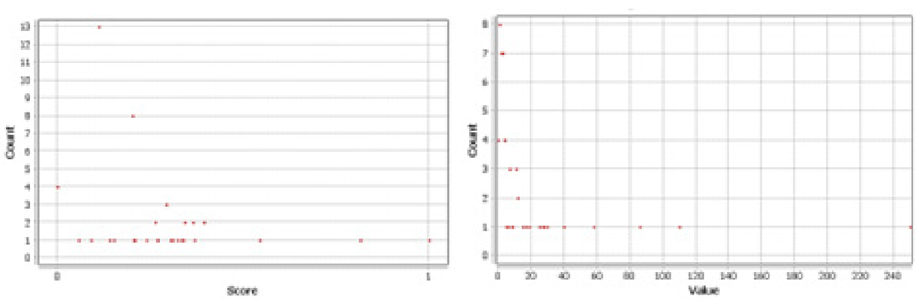


Figure 18. TSNA Education and knowledge creation cluster in Calabria in 2019.

Pink nodes = LMAs, and green nodes = sectors. The size of the LMA node reflects the total no. of units in all sectors found in that LMA, whereas the sector's node size is the aggregated no. of establishments in the corresponding sector. Edge's width is no. of units in each sector in the connected LMA.



(a) (b)

Figure 19. (a) Degree distribution and (b) eigenvector centrality distribution.

4.4. TSNA Education and Knowledge Creation Cluster

This process's first level (intra-cluster perspective) results include 45 interactive network nodes highlighted in red, while nine of the "Education and creation" cluster sectors are demonstrated in green. At first glance, it is essential to mention the core/periphery network formation level in both levels. It is clearly shown that the critical cities play a significant role in the education knowledge diffusion, while the small share of the others is neglectable. More in detail, we can mention the degree of connection between "Other Education Means", which primarily relies on the private universities and training centres and the two main hubs of the Calabria region. To be more precise in this result, we can group the territory into two vividly separated boundaries where Cosenza and Reggio Calabria, as the primary hosts of the Calabrian Universities, are located. Not only university studies but also the research sector are both complicated/ knowledge creation software is well connected to them; however, the Cosenza has a strong connection even with other components of the "Education and creation" cluster.

4.5. TSNA Emerging Industries: Blue Growth

In the last part of this chapter, we investigate the model for the Blue Growth on the most up-to-date dataset (2019). The primarily generated graph demonstrates the LMAs on the horizontal line, and the 13 circles demonstrate contributing clusters (Figure 20). Thus, we see this adimensional modelling tends to characterize the degree of relevance between the territorial potential for inclusive transition and the share of each cluster as a critical mass. Another exciting fact harvested from this complex structure is that Cosenza is considered a hinterland territory, but sector agglomeration made these LMAs the central hub. This can be explained by the fact that Blue Growth has sectors that do not directly interact with the sea, yet they offer services such as advertising and logistics. The variety of the sectors (high number of the contributors) and the consistency in the nodes' degree representing the level of connection compared to the network density is left-skewed. Although 15 clusters form the Blue Growth emerging industry from those, only five construct more than 60% of the establishments in respective clusters and the rest of the economic sectors play an inconspicuous role on a broader image.

This model is still in the initial simulation steps; data limitation in transitional indicators is considered an obstacle to forecasting and policy estimation frameworks where we aim to vigorously investigate the future of the complex transition scenarios at the territorial level. As mentioned in the first chapter, it is essential to respond to the global transition requirements at the local level. Thus, having a new perspective on cross-sectorial future industries forming critical mass for megatrends is interpreted as the next steps for this kind of study.

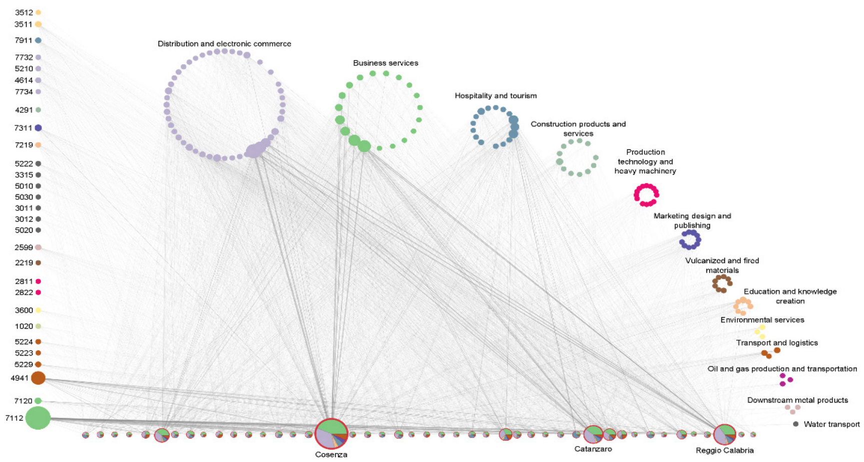


Figure 20 TSNA of all clusters contributed to form Blue Growth (BG) in 2019

. Linkages between Blue Growth industries sectors and the parent clusters for the number of establishments in Calabria for 2019. Circles are the parents' clusters, horizontal line is Local Labour Market Areas, and vertical line is Blue Growth sectors.

5. Conclusion

On the one hand, understanding industrial clusters within a region is crucial to identifying the local economic structure. On the other hand, there is a need for a new modelling framework that can better capture the systems' relations and their structure. The more complex the system becomes, the more integral the network becomes in order to accommodate this complexity. This paper targets exploration of the network analysis techniques potentials in the economic geography for exploring the complexity of the context to face an inclusive transition. The analysis shows how LMAs and clusters are integrated and evaluates the level of preparedness of the context. The analysis shows the nature of sectors in Calabria.

Furthermore, it reveals the connections between all LMAs. The reasoning in this research follows Porter's efforts on the cluster-based analysis to investigate the economic structure. Thus, we aim to demonstrate a novel classification model for the transition potential of a region. To describe this strategy in more detail, the economic sectors are grouped, and then these aggregations will be considered the first layer of a two-mode network. On the other hand, LMAs construct the second layer of the network. Next, the connection (tie) is defined when two LMAs are connected by hosting the same sector (4 digits) within a cluster in the same year. Finally, the proposed tool, Territorial Social Networking Analysis (TSNA), is compounded by the networking structure as an a-dimensional model. This would help analyse the system's complexity to capture the spreading nature of the knowledge flow.

We examined clusters and the economic structure at a different level. First, we created a single territorial dimension network hosting 358 economic sectors on 45 LMAs. We investigate the economic network density, centrality, and degree distribution. We used these metrics to interpret the case study's economic structure composition. Second, we randomly selected eight clusters of different sizes to examine the connectivity. The results show that having a small number of establishments in a specific cluster does not mean low potential. We found that such clusters as the "Food processing and manufacturing" cluster as well as the "Hospitality and tourism" cluster have at least one establishment in all LMAs. Our interpretation for this is that the more connections the cluster has, the more resilient it is. Third, we started our analysis by examining only one cluster and its linkages. The "education and knowledge creation" cluster's network shows the knowledge and research infrastructure of the region; in this way, we examined the competency of the cluster sectors and the connection between LMAs. We observed the network's core-periphery image, which shows that education infrastructure is fragile.

Meanwhile, the highest number of establishments are in "Other education n.e.c.", which also indicates that the education system's focus is mainly on tutoring and skills training. Fourth, we tried to see how far we could go with networks and to what extent networks could reveal systems' complexity. We selected one of the emerging industries (Blue Growth) to run the examination. Emerging industries arise from clusters as a consequence of megatrends. They were formed from the most vital sectors in each cluster that could compete globally. Network analysis allows us to visualize this formation and put together 15 clusters to see which sectors were considered more innovative and competitive. We can see that the "Fishing and fishing products" cluster, "Electric power generation and transmission" cluster, and "Water transportation" cluster have the highest shares of sectors in Blue Growth industries. Although the European commission already makes this classification for emerging industries, network visualization helps us understand the powerful sectors and the associated clusters.

Proposed Networking analysis methods do not only act as a graph to illustrate a phenomenon, but are also a way to form a complex model. The model has the ability to perform dynamic reactions to real-time data; it follows the complex theory and fits the non-linearity of the system. Furthermore, networking analysis has the potential to overlap layers (different annotation for a node in various coordination) and create multi-variant functions.

In sum, networks are an appropriate conceptualization of inter-organizational interaction and knowledge flows. We claim that TSNA for industrial clusters is a promising tool for future directions in regional studies. The visualization of cluster networks helps us understand the complexity of cluster-based analysis in Calabria. Moreover, networks help to highlight patterns in the data visually. When the nodes are geographically mapped, the interpretation of the networks is enhanced because, for instance, geographic clusters become immediately spottable.

For future development, we see that understanding the performance of the industry clusters could be well examined if we add different aspects. For example, investigating the innovative behaviour of a cluster or the investments trend. Following this point, multilayer networks or multiplex networks would be our next step of analysing and understanding clusters and firms in a region. The complexity can neither be reduced nor neglected, but absorbing the dimensions requires a holistic perspective.

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Chapter 3

Technological Resilience "Pandemic opportunities to assess communities"

Abstract

Boston is historically known as a city of knowledge. Hosting MIT, Harvard, and many more universities, as well as the gigantic tech and biopharmaceutical companies, provides exceptional opportunities for this urban area to develop. As explained earlier, the transition is a consistent process embedded in an evolutionary pattern. In this chapter, we explore the Boston transition. Previously we introduced the theory and a test result in this section, and we are conducting two more experiments: first, we explore Boston's technological resilience. At the same time, Boston faced a dramatic global shock (Covid 19). Next, we are giving more room to community-level interactions and mapping their social connection with a public center for non-emergency notifications. This chapter aims to show how big data drive facilitate researchers to create a measure and how the city's technological infrastructure paves the way for social and future physical connection.

Introduction of chapter 3

1. Intorduction

As a result of the use of place-based theory in this chapter, we have tried to convey the concept of urban resilience. Throughout this thesis, we have discussed urban transition, complex systems, and network modeling to get to this point, where we describe how resilience can be put into a practical framework and analyzed in a practical context. Biology, psychology, and even urban resilience have different theories of resilience in various disciplines based primarily on biology and engineering (Van Breda, 2001; Bodin & Wiman, 2004; Janssen & Ostrom, 2006; Sapountzaki, 2007; Herrman et al., 2011; Bhamra et al., 2011; Martin-Breen & Anderies, 2011; Wu et al., 2013; Ishak et al., 2020) . A theory of resilience refers to the idea that the system, after experiencing a shock or stress, will return to the phase before the shock or stress occurs. As well as this, there is also a theory that follows evolutionary theories in which we have the transition process in conjunction with resilience in theory. Finally, a concept called resilience describes the production and adaptation of a system in the face of shocks and stresses.

Furthermore, there are also theories based on fuzzy (Pendall et al., 2010) , unstable (Reggiani et al., 2002) , and non-complex systems (Urquiza et al., 2021) that assert that resilience is making the best path for durability within these systems. It is in this chapter that we analyze both how we can assess resilience as well as how we can measure it. In addition to the theoretical framework, we have discussed throughout the research project, there is also a practical assessment based on networks included in this chapter. As a result of the fact that resilience is an evolutionary process, we do not believe that one can confine it to a specific geographical region; we describe a local area through the lens of a network of all influences and environmental factors, and then we describe the resilience of the network, leading to an analysis of the resilience of the node itself. In a more specific manner, resilience can show itself in different ways, but at the core of the matter is the fact that a phenomenon having a resilience process takes form when we have a network with a degree of diversification and robustness that is sufficient. In order to understand what factors, have unique connections facing interconnects, it is necessary to draw the environment around it in the form of a network, as we observed in the previous chapter. It is a sign of wearability of the system when we get links around one component or even lower than that around a part of the component in order to facilitate the system functionality. It is possible to describe various connections in a stable system because they strengthen the collection. Therefore, we first describe in the first part of this chapter a domain of resilience: technological resilience.

Baland and other scholars (Balland et al., 2015; Rocchetta & Mina, 2019; Amadi-Echendu & Thopil, 2020) describe this resilience in his publications. The objective of technological resilience from an economic or geographical perspective is not our only objective. Taking a step back, we see technological resilience as a domain that requires free and fair access to all parts of the urban system for it to be resilient. There are three parts of the system: residents, policymakers, and policy users.

Boston, MA, is selected for this high-dimensional and data-required research context. First, the concept of technological resilience is tested and addressed based on the accessibility of people. Then, we intend to do this to understand how this system could maintain its access to technology as it changes in the future. In this chapter, we will analyze through an article the use of green technologies in different neighborhoods of Boston before and during the pandemic and how accessible they were before and during the pandemic. In addition, we also analyze how accessible Boston residents are to the 311 networks, which is a non-emergency service for Boston residents. Finally, the network and a methodology are used to analyze how we might be able to draw a network within different neighborhoods in Boston and figure out a rule that will give them a unique identity, as well as a rule that will give them the same identity based on their access to this network; at the beginning of this chapter, we discuss resilience and place-based resilience in particular. As a next step, we examine Boston's resilience plan during a pandemic. Afterward, we will introduce the drafts of two essays that will be published shortly. As a conclusion, we will conclude this chapter with a discussion conclusion.

2. Technological resilience concepts and approaches

Due to the increasing need for technology among city residents, cities need special technologies. This need is manifested in cloud computing, data analytics, mobile communication, and social applications (Batty et al., 2012; Sánchez-Corcuera et al., 2019). These technologies define cities' identities, and their resilience is affected. As a result of the increasing numbers of people living in cities, many improvements have been made to them. However, city shocks and stresses increase as a result of ill-equipped technologies. The result is an increase in shocks due to three types of largely unimproved technologies. First, we need smarter structures to accommodate rapid urbanization and land expansion. Second, local governance relies heavily on technology. For example, sensors and thermostats can be used in risk areas to monitor climate change. Third, cities and technologies can form a unified front that helps globally. We can make technologies on a local level that help us on a global level. By using energy sensors on a local scale, regional and national governments can control energy consumption in a way that benefits them.

A great deal of change can also be avoided if technology is used to improve the robustness of technologies. In previous chapters, we discussed how a network's quality increases as density increases. Our view of urban resilience begins with an evolutionary and comprehensive view of a city's response to shocks and stresses (Pendall et al., 2010; Reggiani et al., 2002). As a result of this evolutionary approach, strategies are developed to help the city pass any crises it may face in the future based on its previous engagements. Urban resilience involves several steps. Using it, a network's weak points are found, and a solution is given immediately, as well as a long-term response to strengthen it (O'Kelly, 2015; Kim et al., 2016; Zhang & Wang, 2016). In technology, this process is much faster, denser, and has a higher success rate.

Technology resilience processes can be categorized into two levels. Managing risks and creating solutions are the first steps. By solving current crises, we can decrease the collection of dangers against the city by predicting the problems we will face in the future. Using current risks and crises, we can make an entangled network of problems to predict problems for the future. As a result, we give a nonlinear response to a crisis, which means we can affect several crises at once. A majority of solution creation can be attributed to the technology sector. Through technology, we can face risks at the first level more effectively and prepare the four main mentioned domains of technologies for a city to respond effectively to risks. Effective crisis response requires a place-based approach. As a result of these solutions, we can respond to a city's risks by utilizing its culture, science, and innovation. There is a much more detailed phase at the second level. There are six steps to knowing risks and responding to them resiliently, including awarenessm, protection, discovery, preparedness, recovery and improvement (Arghandeh et al., 2016). It is important to understand what the technology systems depend on, how critical each component and element is, and what the minimum acceptable service and operational levels should be.

Whenever intelligent systems supporting evolutionary processes are severely disrupted or fail, it is essential to consider the recovery time, capacity, and performance requirements. In order to identify these, technology impact assessments/analyses (TIAs) are necessary. Having access controls and physical security measures is not enough to protect the system. In addition, recovery and improvement mean removing single points of failure, e.g., to reduce the risk of system failure. Because single-linked networks are inherently vulnerable to system failures, they cannot maintain firmly or evolve along evolutionary transitions. Knowing when a failure occurs is discovery in the six mentioned steps. Effective methods of alerting management can identify and address problems before they cause major disruptions. It is within this property of technological resilience that policymakers and executive agencies can pinpoint the problem›s distribution because of the city›s social network at the neighborhood level. According to our earlier discussion (Chapter 2), discovery levels depend highly on network density to insure the level of robustness. It is important to be prepared for disruptions by developing specific action steps and plans. Action plan specifications are based on the place-based approach, where awareness, discovery, and protection comprise general formulas for implementing resilience. Preparedness, however, stems from grass-root actions taken by the community that holds the places cultural, geographical, and historical roots. After an acute shock, within a defined timeframe and with minimal unacceptable quality loss, recovery aims to return services and operations to business as usual.

This process provides a quick and agile solution to shocks and possible stresses. Defining a bouncing back (Aldunce et al., 2014) strategy may not be the optimal goal of system discovery; however, returning to a state where citizens can access the same services is the most important goal. We improve disaster recovery and function continuity by improving systems, increasing resilience, and constantly refining disaster recovery and business continuity plans. In some scholars, resilience refers to the ability to bounce back from large shocks to a precondition (Russpatrick et al., 2021), while in others, it refers to the ability to re-create something new and stronger after a shock (Matthewman & Byrd, 2022). Another definition of resilience is a city's ability to overcome adverse effects of a shock, as well as the policies and structures that can be put in place to deal with future shocks (Zhou et al., 2021).

In order to find the bottom causes of disruptions, this process starts with a review and assessment. By understanding potential issues and implementing preventative measures, policymakers and citizens can prevent severe disruptions or at least mitigate them. By studying all six steps, we can develop a conceptual evolution process based on the city's technological resilience after it enters the global arena. Residents and investors benefit from sustainable, resilient cities. However, a large number of stakeholders has hindered cities. Private investment in these public infrastructure projects should be attracted by new business models and pressure to meet sustainability commitments. By combining these approaches, cities will be more than just smart - they will be sustainable and resilient for their residents, thereby increasing their investment potential.

2.31. Inclusive transition: a place-based approach to a structural change

Urban planning and design applications of resilience are newer than theories about the concept from the 1970s (Meerow et al., 2016; Sharifi & Yamagata, 2018; Masnavi et al., 2019). The term resilience in urban design is still ambiguous, even though theoretical frameworks have been proposed with a spatial concept. In a recent conceptualization, resilience is referred to as the "capacity to adapt to changes" in social, economic, political, and environmental contexts (Julita-Elena et al., 2015; Rahi, 2019). An urban place that is resilient can adapt to changes in urban metabolism and system performance that might occur in the future. Urban systems can survive and develop locally based on the place and its significance in the city's design. A change in physical-structural views, coupled with ecological-social and perceptual-environmental perspectives, has taken place in the last decade in urban resilience. Recent literature has defined urban resilience as the ability of communities and systems to cope with increasing pressures and shocks and to grow in the face of them (Friend & Moench, 2013; Borsekova et al., 2018; Zhikharevich et al., 2021; Büyüközkan et al., 2022). Furthermore, resilience involves analyzing societal characteristics in addition to risk conditions and recovery and reorganization periods, which is why resilience is considered to go beyond vulnerability. In urban systems, resilience refers to their ability to maintain critical functions, even if that does not necessarily imply returning to pre-crisis levels. Adaptability and acceptance of change are other resilience options in the multi-equilibrium approach, which is rooted in ecological resilience. In contrast to the traditional concept of resilience and stability against change, adaptability in a system creates resilience in terms of adaptation and change. In addition, local community participation and capability are critical to adaptive adaptation outcomes. In other words, resilience refers to mitigating threats (i.e., reducing vulnerability) and adapting to their effects. In the face of constant change, resilience emphasizes the interdependence of man/woman and the environment from an interpretive and non-equilibrium perspective. As a result, resilient urban design has emerged as a new way to improve a place's ability to adapt to leading changes, particularly in this context. In their conceptualization of spatial resilience, Cumming et al (Khalatbari-Soltani et al., 2020) describe it as a process that works at different spatial scales and situations. This research illustrates the quality of the complex system perspective in the previous chapter by presenting spatial and scale effects, connectivity, spatial heterogeneity, and context. Today, urban development needs to be resilient, and place plays a significant role in shaping urban textures, which affects the ability of urban systems to survive. Several concepts have been discussed concerning spatial resilience, including multidimensional networks, interactions and exchanges between them, place adaptability to permanent stability and immutability, innovation and creativity of local communities, and synchronicity between city form, content, and performance. It is evident that such integration enhances the place's resilience and ensures its livability and vitality in changing economic, social, and environmental circumstances. Resilience is characterized by adaptability. Climate resilience refers to the ability to adjust natural and human systems to environmental hazards, allowing individuals to respond creatively to unexpected situations. Direct relationships between communities and institutions facilitate learning, innovation, and a willingness to address new challenges. As a result of self-organizing communities and institutional creativity within territorial systems, spatial resilience is a response to change. Mobile phones, intelligent applications, and the Internet can be used more effectively, for example, to monitor the epidemic of Covid 19 at the local level and to strengthen public learning and innovation at the local level. A social and ecological system's ability to adapt and change in response to stress and stressors is called evolutionary resilience, also called socio-ecological resilience. It challenges the notion of equilibrium, meaning it does not return to the pre-event situation. Social, economic, and ecological power is created when the system is altered and revitalized. Spatial resilience depends on unbalanced and dynamic dynamics. As a result of the interaction between the components, all or part of them evolve simultaneously. Creating knowledge and understanding through learning, adapting, and evolving on a local scale and beyond is a prerequisite for the completeness of an urban system. Space resilience is characterized by the ability to adapt fully and self-sufficiently to environmental factors due to learning and innovation. As cities undergo digital transformations, their leadership and governance structures must become more flexible and resilient to meet future challenges. In the civic tech/intelligent cities/digital transformation space today, much of the energy is focused on a small number of city services that generate revenue, like parking or transportation. In order to mitigate resilience challenges, technology-based solutions must be successfully applied. Technology can be applied to city business processes. Technological resilience strategies can greatly enhance the opportunity to fill the gap. Through these strategies, cities have identified and prioritized initiatives to address specific shocks and stresses. Innovation technology solutions for resilience can be used in these initiatives to develop new use cases. In order for urban living experiences to be inclusive, a place-based strategy for technological resilience emphasizes the need for inclusion in a variety of aspects, not just technology but also social applications for easing lifestyles, enhancing community partnerships, and engaging neighborhoods are vital to enhancing the cultural, political, and physical assets of a community. The concept of spatial resilience highlights the evolution of heterogeneous and dynamic components. Moreover, it emphasizes the importance of preserving the socio-ecological heritage of the place and the ability to adapt and learn despite changes while maintaining its meaning, history, and identity. Recent progress in resilience literature has been made in various areas of spatial resilience, a recent approach in evolutionary resilience discourse. Nevertheless, the background of the subject suggests different definitions. Multidimensionality and interactions between different morphological scales are two main implications of spatial resilience in the literature. In the spatial resilience literature, indoor and outdoor environments have been conceptualized according to their roles and characteristics in resilience. Spatial resilience emphasizes adaptability as a critical feature, so even if a vulnerability is reduced, it is essential to adjust to progressive conditions and transform to a stable state of affairs. Spatial adaptation involves increasing the self-organizing capacity of local communities using the creativity of local institutions and communities. As successive changes affect each element and component of space, spatial resilience is dynamic, non-equilibrium, and non-static. Regardless of chronic stresses and acute shocks, urban resilience can survive, adapt, and grow, according to the resilient city network. Through interaction, all or some of these components evolve simultaneously. For example, natural disasters are not categorized as "disasters" or "catastrophes" but as "natural events" and are a critical component of urban structure and development. Moreover, the importance of place, connections, integration, and context is emphasized in spatial resilience theory to increase a place's resilience. As a connecting thread, adaptability redefines all the components of place based on their semantic roles in place due to the identity of place in the face of change. By rebalancing contemporary discourses, spatial resilience theory can improve practice (urban design). However, additional research and in-depth analysis are required for a more accurate definition of operational dimensions. The limited resources in this field and the novelty of spatial resilience in urban design were the limitations of this study.

2.3.2. Boston resilience strategy on inclusion

Several complex causes and roots of inequity cannot be easily resolved. Economic inequality, housing, transportation instability, flooding, and sea level rise continue to challenge Bostonians, despite recent economic growth and its great diversity. In order to achieve Boston's goals and overcome its challenges, racial equity, social justice, and social cohesion must be at the forefront of the city's collective focus. Boston's Resilience Strategy (Chu & Cannon, 2021; Meerow et al., 2019) can be strengthened by applying a racial equity framework and preparing residents to flourish despite shocks and stresses by applying a racial equity framework. In this manner, a person's race will no longer determine his or her success, and all outcomes will be improved. Racial equity goes beyond the absence of racial discrimination and inequities through reflection, proactive measures, and preventative measures. As well, racism hinders the development of social ties between neighbors within a neighborhood. The ability of a community to recover from major emergencies is strongly influenced by its social cohesiveness.

Vision, goals, and actions are based on the resilience strategy, which provides an underlying structure. By incorporating racial justice into every element of the strategy. Boston residents, regardless of race, will benefit from addressing inequities. As part of the development of this framework, BRC (Boston Resilience Collaborative) was closely involved. For Boston's upcoming Resilience Strategy, more than 100 local experts have been involved in the BRC's Working Group Collaborative. the city faces many challenges, but it can overcome them by following the steps outlined in Boston's Resilience Strategy. Boston must reflect on its history and confront the current realities of racism every day and in emergency situations in order to reduce the impact of trauma on individual and community health and well-being. Racism must be addressed by Bostonians and organizations across all sectors to achieve true resilience. To understand structural racism, it must make deliberate efforts and understand how it has impacted and continues to affect it.

Collaboration and proactive government are key elements to enhancing the quality of life for residents. There must be a systematic shift in how Boston organizations and people solve problems to address resilience and racial equity. Connecting households and families affected by government decisions and developing multi-sector partnerships will make the government more effective. To ensure economic security and close the wealth gap, people do not need to be of a particular race or ethnicity. A resilient Boston is one in which all Bostonians can cope with short-term shocks and long-term stresses due to equal access to economic resources. Connecting communities of color to critical infrastructure while improving the quality of life for all Bostonians. Despite excellent accessibility and a wide variety of modes of transportation, most of Boston's households of color depend on transit for transportation. In order to ensure equitable opportunities and a resilient population, transportation access and commute times need to be improved. Boston is also experiencing the effects of a changing climate, in addition to extreme temperatures, sea level rise, and heavy precipitation. In addition to these threats, older adults, children, low-income individuals, and persons with disabilities will be disproportionately affected. It will provide a framework for preserving, enhancing, and embracing growth as the city's first citywide plan in fifty years takes on these challenges.

With Age-Friendly Boston, the city's public agencies, community organizations, businesses, and cultural, educational, and religious institutions are challenged to consider how policies and practices can be altered to improve the quality of life for older residents. As part of a renaissance of arts and culture, Boston Creates seeks to embed arts, culture, and creativity into the fabric of the city. Boston residents need education and job training resources urgently. In addition to curriculum and instruction reform, Build Boston Public Schools will provide a strategic framework for facility investments based on the district's educational vision. Boston Small Business Plan outlines how the city will support the growth and development of small businesses. As a result of streamlining small business services, the plan demonstrates a commitment to understanding the needs of small businesses in Boston. To prepare for climate change, Climate Ready Boston is developing climate-resilient solutions. Women, minorities, veterans, new Bostonians, children, people with disabilities, and seniors will benefit from the Economic Inclusion Equity Agenda as it creates an inclusive Boston and provides ladders of opportunity. Boston's resilience shows a city's ability to overcome the economic shock of industrial decline and the disaster of a bombing. Former subway riders in Boston and the District of Columbia stopped riding public transportation. As a result of various pandemic policies varying across suburban and urban jurisdictions, many knowledge economies, including Boston and Seattle, have experienced a significantly slower recovery. Public and private decisions will determine how the economy is managed after a pandemic. A new normal will not emerge until labor shortages, supply chain disruptions, and inflation are fully addressed. To accommodate population growth, more than 53,000 housing units will be built to meet the needs of all Boston residents regardless of their race, age, economic status, or physical ability.

2.3.3. Pandemic in Boston

Historically, urban sociologists have been interested in the causes and consequences of the growth and decline of cities and their suburbs. Following the Covid_19 pandemic, such interests have become increasingly relevant. Throughout these discussions about cities' unique nature, density and agglomeration are central themes. A pandemic such as Covid19 is the latest of such shocks and has caused widespread damage. Dense urban areas had to physically separate to prioritize public health as pandemic conditions necessitated separation (Harris et al., 2021) . Commercial and industrial activity was halted due to several physical lockdowns in the city (Donthu & Gustafsson, 2020). Similarly, the urban condition sparked intense and enduring debates about socio-economic inequalities (Weil, 2021). Across metropolitan areas and their cities and suburbs, these conversations are deeply intertwined with historical patterns of development and urbanization. Due to the Covid-19 pandemic, longstanding debates about racial and class inequalities have resurfaced. There are many questions about housing, transportation, and economics due to the physical separation imposed by the pandemic conditions (Basu & Ferreira, 2021); dense urban areas were naturally re-shaped to prioritize public health by de-densification. Many commercial and industrial activities were halted due to various physical lockdowns in the city (Hussain et al., 2021). Socioeconomic inequalities that define the urban condition also sparked intense and sustained debates about these conditions. American cities, their physical environment, suburbs, and their historical development patterns are deeply entwined in these conversations. As a result of Covid19, longstanding debates about spatialized inequalities have been reignited. As the pandemic exacerbates and reveals such problems, there are many questions regarding housing, transportation, economic development, and social inequality. An analysis of how the pandemic impacts cities requires a comparative, analytical approach due to the spatial interconnectedness of cities and suburbs. The Covid-19 pandemic brought human civilization to its knees; people are all around the world were affected by this novel coronavirus due to its global scale while the worst scenarios occurred at high density urban areas. The shock was most severe in urban environments because of their dense form and function. The pandemic affected all parts of the USA, from Manhattan to rural America. Metropolises often experienced stronger social and economic impacts of the virus because it spread faster in urban areas. In case of Boston, when we analysis the past acute shocks, it is important to review the history of the city by the end of the 1970s, Boston's economy was deindustrialized and stagnant, but by the end of the 20th century, it had reinvented itself and sparked a new era of social and economic progress. Biotechnology, robotics, and chemical processing were among the industries where Boston leveraged the intellectual surplus provided by its academic institutions. As exemplified by the "Boston Strong" ideology, the city's ability to bounce back after the Boston Marathon bombing highlights the importance of social capital and community resilience in building strong cities. Various disruptions have occurred in society as we know it due to the COVID-19 pandemic.

Loss of employment and difficult work environments was exacerbated the hardships of low-income households. Historically, Boston has been unfavorable to low-income workers because of its spatial mismatches. Mass transit ridership in the region had declined before COVID-19, while private cars and TNCs continued to grow. For the second year in a row, in 2019 among other cities Boston was ranked the most congested city. As a result of the Covid pandemic, the private car ownership rate is at a tipping point in terms of transit demand. Within a week of the Boston pandemic onset, mass transit ridership dropped to 85% below expected levels. Despite some improvements, transit ridership is expected to take a long time to recover to pre-COVID levels. Safety continues to be a concern for transit riders, especially since other passengers may not adhere to safety precautions. As a result, mass transit agencies like the MBTA were losing passengers and revenue due to physical distancing. A strained operating budget is further strained by the need to maintaince vehicles and provide safety equipment to employees. The post-COVID recovery period is estimated difficult for most transit agencies without federal and state funding. As exemplified by its recent proposal to cut service, the cracks are already appearing in the MBTA's attempt to adapt to 'new' ridership patterns. There have been some changes to Boston's climate change ecosystem in recent years. Is the flexible demand management strategy planned to include the new carbon-free incentives scheduled for 2022? Will they be added to existing routes? In response to mass energy demand or extreme weather, will real-time energy information be accompanied by a broader supply strategy?

3. Conclusion

The focus of this chapter is on modeling Boston specifically. Using resilience theories and their connection to transition theories, we conducted a case study of Boston city in response to a bid shock similar to the Covid-19 shock. The first step in the process was to introduce Boston and describe its resilience strategy in more detail. In the following discussion, we discussed the data before and during the times of the pandemic crisis. Based on information obtained from the Boston Municipality, we described the process for obtaining the permissions required to change the technology in a building on the scale of the building, in accordance with the information obtained. Initially, we set out to determine whether Bostonians were capable of changing their priorities in terms of their expenditures as a first step. It is through this social behavior that we can take responsibility during times of shocks, such as pandemics and climate change. We also intended to introduce a measure of people's technological resilience as a way to assess their tendency to adopt technology before and during the pandemic in order to measure their ability to adapt. An additional research study was conducted on the scale of Boston neighborhoods to determine the level of satisfaction and communicability among residents and residents of these neighborhoods. An open-source and non-emergency system was used to measure the level of connectivity among Bostonians using an open-source and non-emergency system.

As a consequence of this, we developed a dashboard layer in order to help urban authorities and policymakers gain a deeper understanding of Boston's neighborhoods based on the assimilation of similar problems in neighborhoods; based on this; we elaborate new level to identify neighborhoods with the same problems. In addition to the fact that these neighborhoods are close geographically and socially, they are also close in terms of change and resilience, so the network is constructed in accordance with the mathematical rules described in this chapter. Furthermore, the results presented in this chapter may also be seen as a positive step towards the development of a dashboard for the management of cities in the future. This data and methodology will hopefully make it possible for Europe to improve and advance as a result of these data and methodologies. In order to make a meaningful comparison between those in Europe and those in America, particularly those in vulnerable areas, it is necessary to examine the level of data collection, the open data sources, and the method of forming data in the US compared to those in Europe. It has been mentioned that if we increase the level of data collection in the lagging regions and more specifically left behind localities of Europe to what it is in the United States, then we are most likely to be able to make use of the case studies that we analyzed in the United States in Europe.

4. Chapter 3 scientific publication

Introduction

After introducing technological resilience, a new concept and its usage in the urban management domain, we intended to use vast and citable data banks at the end of this thesis and especially at the end of the last chapter of this thesis, which is derived from a learning program created by the TREnD project in Boston for developing tool and using it for predicting models the processes humans face in urban regions during the transition. In fact, what is introduced in this chapter is a tool to understand, decide and assess for policymakers to take full advantage of the relationship of economy and space, human and space, human and economy, and spatial relationships derived from contexts like environmental factors or contextual factors to use for urban transformation. At the end of this chapter, two articles were introduced, both utilizing the time series method. The first article describes how a sudden shock like the Covid pandemic affected Boston's green and sustainable development. During this process, we use different facilities in raw data processing in Boston as a forerunner in urban data management. Using them, we performed a social-cultural comparison to see whether the elements known as a vulnerability of Boston, such as racial disparity or environmental risk factors, had a great deal of effect before or during the covid shock; the idea of this research is in line with the literature review stage of Ph.D. course conducted before the arrival of the researcher in Boston. Also, Corona's health shock significantly changed the stresses and chronic fragility of Boston, or in a way, these stresses were able to dissolve in the bigger shock, and the answer toward the big shock was the small stresses. As a result, the social-cultural dangers of Boston moved toward a better position.
For this reason, we analyzed all the registered requests for processes of physical change of any structures toward following the green buildings regulations(LEED) and came up with a scaling system to see whether the protocol in different regions of Boston was rising or falling and if either trend is available is there a direct relationship to race. They can then use this model in critical situations to help them enable the communities with lower ability to invest in a stable city. This method targeted investment in bigger scales on points that will have disparity in the future. By introducing this essay and its findings in this thesis, we are trying to show that based on technology, resilience toward shocks can have a socio-cultural origin, and trying to find top-down processes to control such natural actions can only lead to failure in imposing economic actions. In the second essay, we discussed using people's perception of space as a related element between different spaces within a city. Therefore we are clustering people's behaviors and comments facing an urban crisis. It is also possible to do regional clustering because the topic of discussion between people is the same. By introducing this perspective to people's comments using the 311 system, we are trying to

show whether people's perceptions toward space can make places far away geographically get closer to each other. This research shows how the bottom-up process enables the citizens to answer the macro needs of society. The topic of the second essay is consistent with the generality of this thesis, which is making materials and tools contribute to city development. This article tries to recognize humans as the life-giving element to the region and the connection. In a way, it shows how a human whose life factors are derived from the place of living may make a meaningful relationship with a human living miles away by sharing perceptions. The critical factor here is that only some of the comments were selected. Instead, it was done by finding the relationship between neighborhoods within the city and scoring the neighborhoods using risk factors. The final network, made with the help of the information in chapters one and two, shows how humans in the form of the place, which helps policymakers use this network to connect spots and draw everyday decisions. These decisions in the past only consisted of part of the city of living or region of living, but neighborhoods are new elements. Finally, both essays address the viewpoint based on the human identity, which is living in space and trying to keep this identity stable to use in the future generation. TREnD project partners in the Aristotle University of Thessaloniki and the partner of Italian counterparts support this effort.

Navigating the green transition during the pandemic equitably: A new perspective on technological resilience among Boston Neighborhoods facing the shock

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Abstract

Cities, public authorities, and private organizations respond to climate change with a variety of green policies and strategies to enhance community resilience. However, these community-level transition processes are complex and have not been well understood and conceptualized. This paper proposes an integrated framework to conceptualize community-level energy actions from a big data perspective by advancing studies on community energy and socio-technical green energy transitions. The paper first introduces the topic of green transition by addressing the following question: What are the main factors that affect a city's performance in achieving the vision of green transition and carbon neutrality? How has the healthcare crisis and the subsequent shock affected its different neighborhoods? The study aims at answering this research question through a literature review of different resilience policies and practices for the transformation of city ecosystems towards green neutrality, and uses the City of Boston as a main case study to reveal different neighborhood's inequities achieving this vision. The theoretical framework builds the linkages among the city's measures, climate actions proposed by the City of Boston and their associated contexts and outcomes in shaping new policy and planning models for higher 'green' performance and is applied in a comparative study of its 23 neighborhoods, using a dataset provided by Boston Area Research Initiative (BARI). Hence, neighborhoods which better tackle the grand challenge of environmental sustainability and climate change are identified through the detection of city patterns with high numbers of building permits related to green transition for the period of one year before and one year during the pandemic. Following the identification, the socio-economic data of the neighborhoods were assessed, in an attempt to understand whether economic disparities exacerbated during the pandemic have affected neighborhoods' performance in green transition. Intriguingly, the paper's findings show that historically claimed racial disparities between Boston's neighbor-

hoods have no significant impact on tech-related expenditures.

Keywords: technological resilience, big data analytics, green transition, urban innovation, climate change, socioeconomic analysis

1. Introduction & Context

1.1 General Observation

The sustainable city discourse is becoming ubiquitous and the need for a long-term strategic approach to create a regional context in which sustainable development is increasingly becoming the norm (Blasi et al., 2022). Wheeler identified sustainability "as requiring a holistic, long-term planning approach, as well as certain general policy directions such as compact urban form, reductions in automobile use, protection of ecosystems, and improved equity" (Wheeler, 2000). By the end of the 20th century, "sustainable city" initiatives began to emerge in different parts of the world (Wheeler, 2000). Then, the arrival of "resilience" as a new concept of urban policy and a buzzword has reformulated the imperatives of sustainability in the context of the environmental crisis (Sharifi & Yamagata, 2022; Zeng et al., 2022). The current resilient sustainable discourse reflects that the city can and should be green but it needs significant innovations (Ahern, 2011). The discourse of sustainable and resilient cities showed that cities are the current major challenge facing sustainable development - this is mainly due to an ever-increasing population density and high energy consumption (e.g. two-thirds of global energy demand). But, at the moment, there is a shift from understanding cities as environmental problems towards cities being understood as the solution to environmental problems on a global scale (Angelo & Wachsmuth, 2020). Urban sustainability has guided the development in urban and metropolitan areas around the globe in lowering their carbon footprints and reducing greenhouse gas emissions by targeting resource and energy consumption in the construction, operation, and maintenance of the urban built environment (Droege, 2018). However, the complex environment that characterizes cities, and specially metropolitans, renders the transition towards sustainability more challenging. The mounting climate pressures have compelled cities and planners to seek more green and innovative alternatives to steer cities and their inhabitants towards sustainable pathways (Jia et al., 2022).

The rapid growth of energy use has caused concerns regarding the supply, the collapse of energy resources, and the severe environmental impacts (Saidur, 2009). The global contributions from buildings towards energy consumption have steadily increased (Pérez-Lombard et al., 2008). Around the world, buildings consume 38% of the world's resources, generate 40% of the waste in landfill sites, and emit 28% of the greenhouse gasses produced on the planet (UNEP, 2020). Moreover, according to the LEED platform, buildings in the United States account for 36% of total energy, use 65% of electricity consumption, and 30% of greenhouse gas emissions on the national level. For this, reducing energy use includes the goal of reducing the electricity needed while obtaining the same or nearly the same results from the building's systems. Improving the energy consumption in buildings is a prime objective to reduce human impacts on the environment at the national and international levels. Greening the buildings has had the world's attention over the last two decades, however, the US is not among the world's 10 leading countries in green building projects (GBCI, 2019).

Despite all the big pronouncements and pledges of the city authorities to become greener, the pandemic has shown us a bitter reality; the world is still very dependent on fossil fuels (Cartier, 2017). Cities are far behind reaching their targets of achieving 100% use of clean energy. In this difficult equation, addressing the existing vulnerabilities, economic disparities, and race inequalities will be key for the cities to become leaders in creating a sustainable future for their residents. The current study works towards this direction, aiming to reveal a variety of inequities in how residents of different neighborhoods and racial and socioeconomic groups have been able to achieve a green transition before and during the pandemic. It uses the Boston metropolitan area data set on building permits to test the hypothesis within the City of Boston that vulnerable communities' socioeconomic context affects neighborhoods' capabilities to achieve green transition. In this line of reasoning, the research tries to conceptualize pillars of measures based on socioeconomic factors and neighborhood physical formation to understand which factors are most relevant to the pandemic shock absorption thus the resilience of the system.

In order to fully weigh the benefits of innovative neighborhoods as a way to achieve a green transition, we begin by identifying the city planning initiatives and discussing the city's climate actions. There are already citywide initiatives to finance energy efficiency in municipal buildings, for example, the Renew Boston Trust. Nevertheless, we seek to evaluate private buildings' implications for deep energy building retrofits, the installation of rooftop solar energy, and the procurement of zero-carbon electricity. The paper uses LEED's green building system assessment standards as a proxy for investigating tech-related permits. The following section provides a brief overview of Boston's climate action plans and policies. In the remaining part of the paper, 23 neighborhoods within the City of Boston will be evaluated on the basis of their individual characteristics and their adoption of green technology. We conclude by discussing the results of the study, in order to provide a sense of the extent to which Boston is considering the advancement of reducing the amount of pollution that is emitted from buildings.

1.2 Research Questions, Goals, Hypothesis

During the last months, we have seen energy prices being dramatically surging as countries and households confront shortages of oil, gas, and coal. In this period, the neighborhoods of Boston need to look at some of the major factors behind the energy crunch, from the role of green policies to the historical housing discrimination affecting homeownership in the city. In this context, the discussion concerning urban informatics around the potential pitfalls of the field that could harbor its overall success in improving cities for the user. One of the biggest concerns is the lack of interconnectivity between studies in different cities of similar types. This seems like a big missed opportunity as it could expose important relationships in the way cities function. Another, perhaps even larger challenge, is maintaining an even level of funding amongst cities for urban informatics, an issue which is not easily solved. Larger cities will have bigger budgets for this manner of project by default, meaning that cities without funding get left behind when it comes to the data analysis of the city. Although data mining and analysis in the urban environment has grown exponentially in recent decades, the organization and execution of how we interact with this data and use it for the public good are still in great need of advancement.

This paper aims to lead the policymakers to pay more profound attention to the neighborhood level to enhance the community level and form a much more robust network to face shocks and stresses. Resilience strategies stem from the technological advancement of communities. Green technologies are knowledge-based assets; thus, local investments could lead the neighborhood to significant developments. Moreover, the current energy crisis has revealed the importance of creating self-sufficient communities that can long term produce the energy they use. This type of open systems, which will allow the regeneration of the energy in buildings, will affect the sustainability of Boston's neighborhoods.

Through our research, we address the following questions; RQ1: what was the role that the pandemic playing in acceleration or slowing Boston's green investments? RQ2: To what extent do different racial and socioeconomic groups invest in green technologies during this period? These questions address the ways the pandemic affected the neighborhoods' investments on green technologies as well as the ways that different racial and socioeconomic groups have been investing in green technologies before and during this recent healthcare crisis. We aim to approach our research as a critical point where we are collecting, analyzing, and visualizing big data which will allow us to understand neighborhoods' dynamics and constraints in green transition.

As urban problems continue to emerge, more data analysis is needed to support continued efforts. Cities are living laboratories and have certainly shifted as a result of the COVID-19 pandemic, so research should attempt to keep up with the latest changes. The recent unrest in cities and local governments necessitates research and expertise, especially since cities were almost breeding grounds for the pandemic. In order to understand cities, reverse current inequalities, researchers must alter perspectives at the city level, such as health crises and provide equal opportunities to all populations, which will certainly require more robust technologies, data, and instruments.

In the end, if the green transition is reliant on public policy or government intervention, there will need to be a transfer of knowledge and associated advocacy to promote change at the neighborhood level. However, awareness of a problem does not necessarily bring a response that will follow suit, and though data can identify relationships, patterns, or problems, it does not always have the power to create change. Translating the findings of the current and similar studies into tangible policy will be the most ambitious goal and challenging aspect of our future work in big data analytics.

The paper sets out the study as follows:

Section 1 presents the topic of green transition and green neutrality as a way to enhance community resilience during the pandemic. It also introduces the two main research questions (Section 1.3). The answer to these questions will provide support to city authorities to improve the current programs and policies they propose to enhance green neutrality at the local, neighborhood scale. Section 2 provides an overview of other studies, previous research attempts and measurement tools in the discourse of big data analytics and urban informatics to identify city areas with better performance in carbon neutrality. (Section 2.2). Section 3 introduces the socio-economic context of the City of Boston, which is used as a case study and provides significant considerations regarding previous strategies and climate actions in support of its green neutrality. It also analyzes significant constraints for Boston's neighborhoods to achieve high performance towards that goal (Section 3.2) and attempts at exploring correlations between 'green' neighborhood performance and socio-economic context (Section 3.3). Section 4 contains a big data driven analysis of city investments on building permits related to green transition, which was used as a main method to provide insights into how different neighborhoods are incorporating green technologies. Section 5 contains the findings with a summary of the range of factors that affect neighborhoods' performance, while section 6 provides conclusions and recommendations for further study.

2. Literature review

2.1 Building a framework for measuring green transition based on other case studies and toolkits

Buildings contribute to 38% of carbon emissions which highlight the need for green buildings (UNEP, 2020). Therefore, over the past two decades, the green building movement started to emerge and new councils for green building were established. The US Green Building Council defined a green building as they "are designed, constructed, and operated to boost environmental, economic, health, and productivity performance over that of conventional building." (USGBC, 2003). As a result, green buildings have become a promising pathway for the nation's sustainable development. New assessment systems developed around the world. For example, the US Green Building Council (USGBC) developed its green building rating system, which is Leadership in Energy & Environmental Design (LEED). Similarly, the Building Research Establishment Environmental Assessment Method (BREEAM) in the UK, and the Green Star in Australia. Among those, the US was one of the most developed areas in green building projects (Cheng & Venkataraman, 2013). For instance, Austin, Texas, is best known for its efforts in green building (Kibert, 2004). It won an award at the first UN conference on sustainable development in Rio de Janeiro in 1992. Subsequently, local residential green building movements rapidly emerged in many American cities such as Denver, Colorado; Kitsap County, Washington; Clark

County, Washington; the Baltimore Suburban Builders Association; and the EarthCraft Houses Program in Atlanta. Besides USGBC, the US has a wide range of green building local organizations that took part in the green building movement. For example, the National Association of Homebuilders issued guidance on how to create a green building program in the local area (NAHB, 2006). Additionally, local and state governments have been highly involved and promoting green building. In 1998, Boulder, Colorado stood up and passed an ordinance requiring specific measures with respect to green building. Moreover, Pennsylvania, for example, made significant efforts to promote green building. It established the Governor's Green Government Council (GGGC) in part to address the implementation of green building principles in the state. The country even made it feasible for everyone and all organizations to be up-to-date regarding everything related to green buildings in the US through the Environmental Building News - a monthly newsletter published by BuildingGreen.

However, investments in green buildings have been very limited. For example, only US$148 billion of the total US$5.6 trillion investment in buildings are allocated to green buildings (UNEP, 2020). Moreover, Debrah et al. revealed the gap of green finance in green building in the research area (Debrah et al., 2022). They pointed out that although the US is dominant in the green investments debate (Zhang et al., 2019), it has very limited academic research in this topic. Their review of the research area worldwide on green investments on buildings shows that "GF-in-GBs [Green Finance in Green Buildings] research has been around for about only a decade now, although both the green finance and green building research fields in general were born in the 1970s". This underpins the crucial need for more studies on green buildings investments.

For this, this study examines the econometrics capturing patterns of a US city's performance in supporting green building projects. We assess Boston's neighborhood growth and 'green' investment through the volume and profile of building permits. We focus on the spreading supply of GHG-free electricity in the City of Boston through the solar energy systems and the rest of LEEDs' certificate related keywords regarding technologies facilitating in building (See table 10). With these keywords, we applied a text analysis algorithm on the notes variable of the aforementioned data set which enlarged the case study by 45% (initial candidates number 42641 to enhanced 78671).

solar	voltage	low emitting
Energy	recycle	Thermal comfort
Tech	waste management	innovation
panel	environmental	refrigerant
renewable	green power	cooling tower

Table 10. Keywords used for supporting the data set based on LEED measurements

In this paper, we evaluate the amount of investments that go to green transition, we assess the number of buildings' tech-related projects such as rooftop solar energy in different neighborhoods, the potential of the city neighborhoods in adopting low- and zero-GHG fuels to reduce emissions, and adapt other green technologies. Our central argument is that innovation is one of the main drivers to post carbon transition at the neighborhood level. Innovation is at the heart of the transition to a cleaner global environment. However, "it is still insufficient to address the environmental challenges facing the planet today" (OECD, 2019). There are some barriers that could limit the green transition such as, lack of public acceptance of new technologies, financial barriers, and innovation capacities (OECD, 2019), and there is evidence to suggest that the pace of green innovation has slowed in recent years. This suggests that major barriers remain and need to be lifted in order to accelerate the transition.

2.2. Technological Resilience as a Factor of Neighborhoods Green Transition Before and During the Pandemic

Technological resilience is a factor of regional resilience that relies on the capacity of a city or region to capture technological changes over time. Balland et. all proposed four pillars to identify this concept in a regional realm (Balland et al., 2015). Although our research deals with similar attributes, we aim to extend this understanding to a local level, where communities have their own evolutionary paths to fulfill transition goals requirements, and local units have their own structural identities based on path dependency. In other words, we are translating the effort of technological resilience conceptualization in regional economic geography into a tangible measurable analysis to generate local maps and models.

According to the mentioned reference, looking at four semitrances aspects: first, evolutionary development path: could be addressed in a way to reveal the crisis effect on the evolution of a city utilizing the neighborhoods as cells of the system. The shock due to the pandemic, stated earlier, changed the course of the investment pattern and emerged a new ornament which creates a local definition of evolutionary development. In this research, we rely on these attributes benefiting from a before/during shock classification.

Second, Path dependency: as explained by scholars there is a strong relationship in the legacy of the history of local units and the current status of the resources. In this research, we brought the structural properties of the neighborhood into the investigation in a way to address the racial configuration and physical characteristics of the neighborhood. Nevertheless, there is a tendency in literature claiming path dependency is an issue for looking at the emerging characteristics of the local units. In this research, we are looking at the mentioned identities under the lens of big data to examine historically claimed status about racial disparities and physical configuration.

3. The case study of Boston

3.1 Assessing Boston as a case study towards a net zero carbon, eq-

uitable and resilient built environment

Boston is an East Coast city with 23 neighborhoods (figure 21). Boston is experiencing increasing sea levels and a range of climatic issues, including flooding, storm surge, and extreme temperatures. Historically, Boston expanded by landfill projects which created new neighborhoods and almost doubled the city's area. Thus, the City of Boston now deals with a vulnerable position on reclaimed land. If sea levels continue to rise in the Boston area, the Climate Ready Boston initiative predicts that by 2070, upward of 90,000 residents in the city will be at severe risk, with billions of dollars of infrastructure, property, and business loss (City of Boston, 2016a, 2016b). Future sea level rise and temperature change depend on how much the world is able to cut carbon emissions. Nevertheless, water is not the only risk, extreme temperatures and heat waves put Boston under threats for public health especially for vulnerable communities. Sasaki analyzed that by 2070s, the annual losses from flooding could cost up to to $1.4 billion, and the exposure to flooding could include 14% of Boston's population (88,000 people), 10% of the city's K-12 schools, 32 MBTA stations, 240 essential public facilities (law enforcement stations, fire stations, and EMS), and sections of many evacuation routes (Sasaki, 2016). On the other hand, extreme heat will increase mortality rates (Sasaki, 2016).

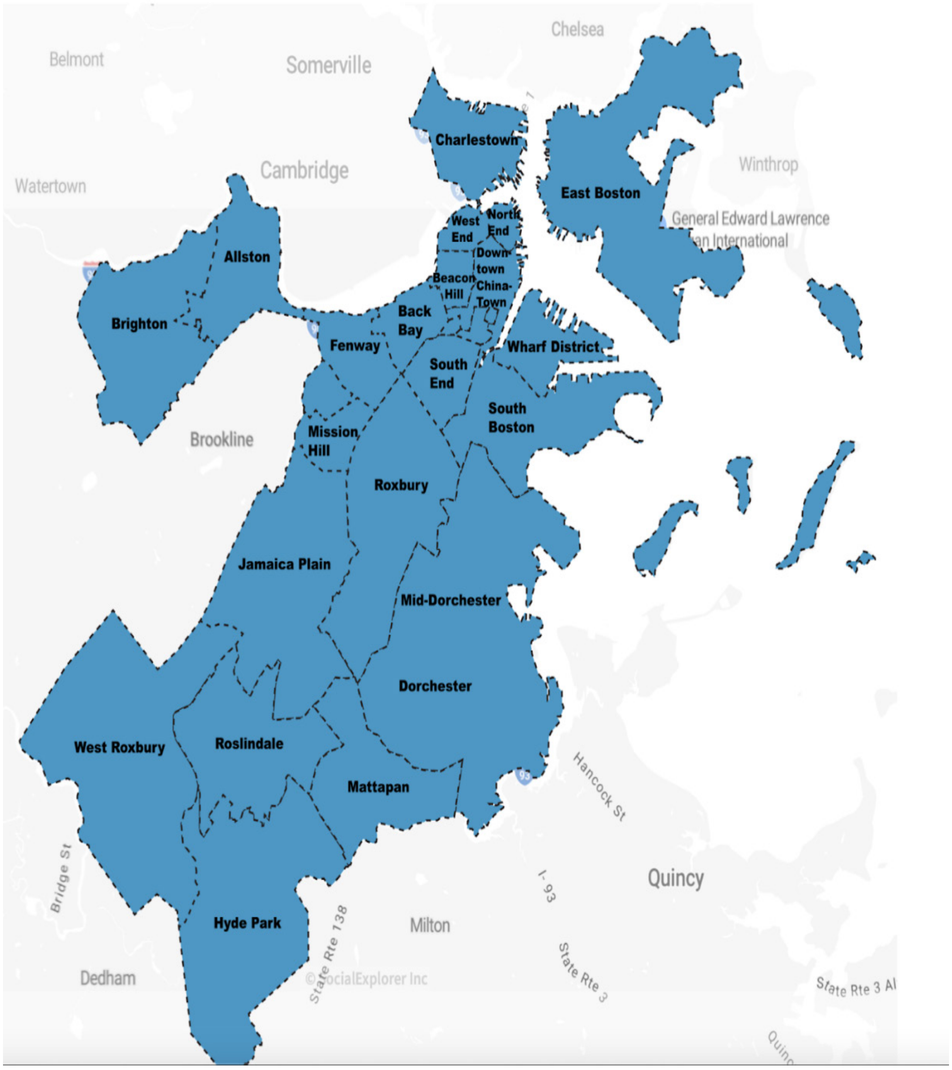

Figure 21 Boston's Neighborhoods

3.2 Previous strategies and climate plans in Boston to understand green transition

Boston's journey toward resilience planning and climate action has been comprehensive since the start of the twenty-first century. In 2000, Boston joined the Cities for Climate Protection Campaign of ICLEI— Local Governments for Sustainability. Through this campaign, Boston pledged to step up for increasing energy efficiency and reducing greenhouse gas emissions. Moreover, Mayor Menino decided to develop and implement a local action plan to fight against greenhouse gas and air pollution emissions. Five years later, Boston adopted the U.S. Mayor Climate Protection Agreement and joined the target of reducing carbon emissions to below 1990 levels. In 2007, the city of Boston released its first citywide climate action plan. Boston's former mayor, Thomas Menino, issued an executive order in 2007 on climate change that set an ambitious goal for the city to reduce its GHG emissions by 80 percent by 2050. In 2008, Massachusetts enacted a law that required "the Department of Environmental Protection to establish targets for GHG emissions reductions below 1990 levels between 10-25 percent by 2020 and 80 percent by 2050." Since then, the city has adopted long-term climate goals such as waste reduction, transportation and mobility, mitigation, and adaptation. The City of Boston started to integrate the community in the action plans and thus in March 2009, Mayor Thomas M. Menino formed the Boston Climate Action Leadership Committee and Community Advisory Committee. The aim of the committee is to propose recommendations to the Mayor and set the goals and objectives that Boston should follow in order to confront the risks of climate change. Hence, over a year community's leaders came together to develop recommendations on buildings, transportation, and adaptation. In 2010, the committee proposed Sparking Boston's Climate Revolution report. This report was fruitful and rich of recommendations to tackle climate change.

Along with Mayor Menino aiming to bring all levels of community together, the Green Ribbon Commission was launched. The commission was a way to engage the city's business and civic leaders for the same goal. It aims at designing and implementing the City's climate adaptation and mitigation strategy. In 2011, Boston set carbon reduction goals of 25 percent by 2020 and 80 percent by 2050 below 2005 levels. Later, Mayor Martin J. Walsh announced that Boston joins the C40 Cities Climate Leadership Group (C40). In 2015, the City of Boston joined the Carbon Neutral Cities Alliance (CNCA) with cities from all over the world. Each city has committed to save the planet and mitigate global warming. A year later, the Mayor launched Climate Ready Boston. It is "an initiative to plan for how the city will continue to thrive while adapting to long-term climate change. It has three main components: climate project consensus (completed by the Boston Research Advisory Group), vulnerability assessment, and resilience initiatives". In 2017, Mayor Walsh announced Boston's goal of carbon neutrality by 2050—an ambitious yet necessary commitment to meet the urgency of the climate challenge (MAPC, 2017). In Imagine Boston 2030, the city's long-term strategic plan, it also sets an interim carbon reduction goal of 50 percent by 2030. Carbon neutrality goal means that Boston is fulfilling the commitment to the Paris Climate Agreement and leading efforts to keep global warming under 1.5

degrees Celsius. By 2017, the City of Boston reduced emissions from municipal buildings and fleets by more than 40 percent below 2005 levels. Based on the progress Boston expects to make in energy efficiency and renewable energy, this Plan increases the reduction goal for municipal operations from 50 percent to 60 percent by 2030.

Boston's most recent climate action plan, released in 2019, sets the stage for Boston's transition to carbon neutrality and describes the roadmap for the next five years (City of Boston, 2019). The 2019 Climate Action Plan (CAP) focuses on strategies to accelerate emissions reductions from three work areas: buildings, transportation, and energy supply. We focus on our study of Boston's buildings as buildings account for over 70% of greenhouse gas emissions in Boston (Eshel, 2021). Boston's two main targets for building are adopting a zero net carbon standard for new constructions by 2030 and retrofitting and electrifying at least 80 percent of exciting buildings over the next 30 years. Adopting a zero net carbon standard by 2030 would cut 17 percent of cumulative emissions from new construction to 2050; adoption by 2023 would cut another 17 percent (City of Boston, 2019). According to the city, reaching carbon neutrality is possible if effective legislation is enacted and implemented in a timely manner. On the other hand, four out of five existing buildings in Boston will need deep energy retrofitting and moving to fossil-fuel-free heating and hot water systems in order to reach carbon neutrality by 2050. Existing building energy retrofitting can lead to reducing the city emissions by up to 40 percent. The City of Boston requires residential buildings that are 20,000 ft2 or larger (excluding parking) or have 15 or more units to reduce their building emissions and to begin reporting their energy use in 2022. By doing this, owners and tenants would become more aware of their energy use and costs, and greenhouse gas emissions. They would be able to compare them to similar size buildings and give opportunities to reduce the energy consumption. The City of Boston suggested that deep energy retrofits should happen by: 1) Upgrading mechanical systems, lighting systems, and appliances; 2) Insulating walls, roofs, crawlspaces, and foundations; 3) Upgrading HVAC and plumbing; 4) Replacing windows; 5) Air sealing; 6) Installing renewable energy systems where possible.

Moreover, the city suggested converting fossil fuel systems to electric equivalents. With deep energy retrofits and electrification, existing buildings can become carbon neutral. There are existing state incentives, such as Mass Save, that helps residents upgrade their energy efficiency and it offers a wide range of services, and incentives. In addition to Mass Save, there are over 14 units that were implemented by E+ Green Building Program launched by the City of Boston in order to regenerative multi-unit residential buildings and bring energy and environmentally positive homes to Boston's neighborhoods. To reach carbon neutrality, the city will need to implement deep energy retrofits and electrification by 2050. Businesses, residents, and the city should invest more in solar panels on building rooftops and other green technologies to have more energy-efficient buildings. In the end, communities will benefit environmentally, socially and economically, since these investments will also spur innovation and job creation.

4. Scope, Methods & Data Collection

The study considers big data analysis as a crucial method to detect patterns and correlations between neighborhood inequalities to effort for lowering prioritization of green transition. It also explores new ways such analyses may afford more opportunities than were previously examined. Hence, the research methodology is structured on assessing the neighborhood's investment level before and during the shock in the City of Boston to find out the most relevant variables for this prioritization. We tested our hypothesis on vulnerable and prospered neighborhoods' behavior against acute shocks. The turbulence in the flow of investment and prioritization in neighborhoods could show the halting factors for an inclusive transition explained earlier in the literature section. The methodology of this research relies on exploring a significant number of observations in the City of Boston to see if the Covid-19 pandemic changed the investment priorities among 23 neighborhoods. This question then could shed light on the inclusiveness issue of transition. Having this in context to answer the research questions stated earlier, we used the Boston Permits dataset published by BARI to capture appropriate information about neighborhoods' tendency toward technological related investment in a pre and post the pandemic shock. We decided to create two equal subsets of observations as follows; twelve months before the pandemic, from 23rd march 2019 - 2020 as pre-pandemic and from 24th march 2020-2021 as during-pandemic.

The following step was to transform the data set from addresses and ZIP codes to the 23 neighborhoods defined by the City of Boston for easier interpretation. Then, we aggregated 435k observations for all recorded permits at the neighborhood level. In order to tackle our questions, we ran a text analysis algorithm to find tech-related projects. After sorting the observations, and creating two time periods, we tried to find a pattern at the neighborhood level. A frequency table was created to compare the number of all permit requests for each period to the number of permits for tech-related projects. Next, to capture the amount of gross investment for each neighborhood on tech-related projects, we did a search on building permit description looking for words that appear on LEED's assessment standards related to energy technologies. This effort revealed a total of 299 building permits aimed at decreasing energy consumption by providing a related technology. Among the keywords listed in the energy section of the LEED, we identified a corpus of 15 keywords that are repeated several times and identified as important to the research question and topic of this paper. By focusing on these keywords, we identified a set of thematic areas which we use as a basis to study the green transition across Boston's neighborhoods before and after COVID-19 pandemic. Then we used the IQR technique and removed outliers due to the high data variance within a neighborhood.

The second step is to compare the frequency of permits requested/issued over two periods. To compare these numbers, we compute the proportion of each category (All permits issued and/or Technology related permits) for each period. To determine the trend of permits issuance, a drop rate was created for each category. Subtracting these two drop rates, we find three possibilities that can be interpreted as follows: 1. The positive sign indicates that technological projects will be less impacted by shock than all other categories, while the negative sign describes a situation in which most of the change will be absorbed by technologically related projects (equation 1).

$$A = \frac{\sum X_A}{\sum (X_A - a)} \quad (1)$$

$$T = \frac{\sum X_T}{\sum (X_T - a)} \quad (2)$$

$$M = A - T \quad (3)$$

where

A is the change rate in the number of all issued permits

T is the change rate in all tech-related permits

X_A is the number of all issued permits

a is change in pre- and post- pandemic

X_T is the number of all tech-related permits

M Proposed technological resilience measure

Next, we quantified the investment per neighborhood in both periods and compared them to find a specific flow. The third step is creating a measure to run a model to determine which possible variables influence the investment in these periods. First, we created a socioeconomic database from the census tract to achieve this goal. The database was created based on three pillars – social, economic, structural. After that, we ran a linear regression in which we constructed a dependent variable of 100 USD invested in tech-related per house in each neighborhood and median income, median home values, race minority, school attainment rate, and poverty rate as independent variables. After running the model, a matrix of 4 residual analyses and Anova explain the model fitness and quality of selected variables.

5. Research Findings & Discussion

Based on the analysis of the patterns of permits issued by the city of Boston over the past decade, it appears that the number of permits issued by the city in 2019-2020 has shown a dramatic decline (see figure 2). As a result of this alteration, the technology-related domain has also been impacted, but the rate of this change has been quite slow. This 2019-2020 period can be compared to the Covid-19 pandemic from 2014-2016 so we may want to pay attention to the shock of this pandemic and its possible effects on the trend, as we mentioned earlier. A major objective of this study is to identify the trend distribution and the possible factors that impact this distribution in the neighborhood level, and then to draw a different line between the general permit rate and the technology-related ones, to determine if there are specific factors that influence these two patterns differently.

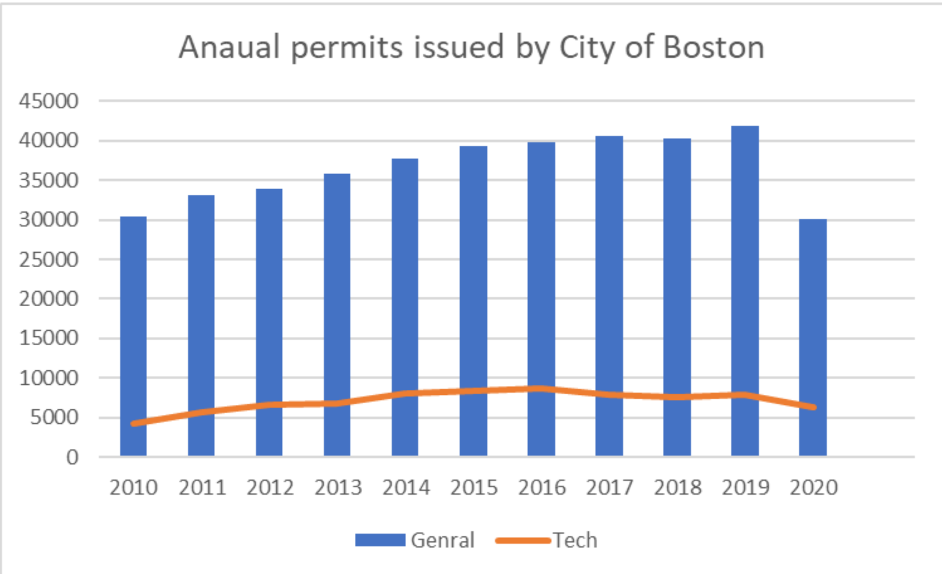

Figure 22 Number of permits issued by City of Boston 2010-2021. Blue is all categories. Orange is Technology related permits.

The first finding regarding the number of the total permissions for the period of one year before and one year during the pandemic differ by 46 percent. In this data set there are 50k records for 2019-2020 and 27k for 2020-2021 (all extracted by specific dates). The second finding reinforces the first by good estimation in the same proportion; the first period contains 8116 records on tech-related projects while the second contains 4679 values. Below is a comparison of drop rates among Boston neighborhoods in the two periods. On average, the number of projects set up dropped by almost half. Its standard deviation is 0.09, which indicates a homogenous and coherent trend. The range is vast, from 25% for the downtown neighborhood to 62% for Chinatown and the financial district. When we examine the technological projects through the lens of frequency, we observe a higher variance that could translate to a gap between areas of Boston, and we introduce this as the first step in technological resilience explorative research. The average drop-in technological rate is 41 percent, which is lower than the drop rate in the total projects. The standard deviation was 0.2 units, a more significant variance that can be interpreted as a measure of preparedness among Boston neighborhoods. The range is from 0.01 in Hyde Park to 0.94 in South End, showing a 0 to almost 100 percent spectrum. We develop a linear difference in called proposed technological resilience measure (See Figure 22) by subtracting the drop rate of technological project frequency from drop rates in all issued permits frequency.

Interestingly, we can observe a polarization of values with negative and positive values (See Figure 22). There was a more significant trend in technology-related projects than in any other type of categories; this means the frequency of 12 neighborhood tech-projects did not decrease as significantly as the rest of neighborhoods. The resilience measure we proposed showed negative values in 8 neighborhoods, but they are relatively minor when compared with the negative rate in South End, which is -0.46. Beacon Hill, Jamaica Plain, and the Wharf District, however, showed no signs of any deterioration during the pandemic.

Table 11 Boston's Neighborhoods and Technological Resilience Measure

	Neighbourhood	No. of projects in pre-pandemic	No. of projects in post-pandemic	Drop rate	No. of tech-related projects in pre-pandemic	No. of tech-related projects in post-pandemic	Drop rate in tech-related projects	Proposed technological resiliency measure
1	Allston	836	477	0.43	118	91	0.23	0.2
2	Back Bay	3354	1486	0.56	798	321	0.6	-0.04
3	Beacon Hill	976	409	0.58	210	88	0.58	0
4	Brighton	1776	1039	0.41	262	152	0.42	-0.01
5	Charlestown	1522	753	0.51	151	76	0.5	0.01
6	Chinatown	1114	418	0.62	228	91	0.6	0.02
7	Dorchester	5446	3301	0.39	761	528	0.31	0.08
8	Downtown	844	647	0.23	214	167	0.22	0.01
9	East Boston	2416	1341	0.44	390	209	0.46	-0.02
10	Fenway_Kenmore	3117	1580	0.49	812	383	0.53	-0.04
11	Hyde Park	1636	1157	0.29	269	249	0.07	0.22
12	Jamaica Plain	2404	1196	0.5	317	157	0.5	0
13	Mattapan	1416	912	0.36	244	223	0.09	0.27
14	Mid_dorchester	1144	635	0.44	171	113	0.34	0.1
15	Mission Hill	528	300	0.43	102	50	0.51	-0.08
16	North End	398	203	0.49	59	25	0.58	-0.09
17	Roslindale	1946	1069	0.45	242	125	0.48	-0.03
18	Roxbury	3258	1971	0.4	470	307	0.35	0.05
19	South Boston	3752	2065	0.45	652	386	0.41	0.04
20	South End	67	35	0.48	18	1	0.94	-0.46
21	West End	1815	771	0.58	481	218	0.55	0.03
22	West Roxbury	1854	1147	0.38	177	143	0.19	0.19
23	Wharf District	1527	561	0.63	390	148	0.62	0.01

Figure 23 Technological Resilience Measure

Having said that, South End, North End, Mission Hill, Fenway-Kenmore, Back Bay, Roslindale, East Boston, and Brighton hold a negative value, sorted in ascending order. As mentioned before, since the decrease rate in tech-related projects is higher than other categories, we can describe this behavior as higher absorption of shock in the Technological domains. Alternatively, we have a list of neighborhoods, including Mattapan, Hyde Park, Allston, West Roxbury, Dorchester, mid-Dorchester, Roxbury, South Boston, China Town, Downtown and Charlestown showing a positive value, descendingly. This group of neighborhoods mitigated the pandemic shock in a way that the lesser amount of recession observed in their technological behavior compared to the general trend of decreasing permissions.

After describing the first layer of this analysis, we turned to creating the measure of the amount of investment per house unit based on the number of occupied houses. As discussed earlier in the methodology, a 100 USD per house unit was selected. Results show two neighborhoods with higher investments, Mattapan, and Allston, 8 and 4 percent, respectively (table 3). In the other 21 neighborhoods, however, things are different. As a result of the pandemic, the budget was reduced by 3 to 100 percent compared to the pre-pandemic year. West Roxbury, Mid-Dorchester and Hyde Park showed around roughly 5 percent reduction of investment. South End, Wharf District, and Chinatown contributed the lowest expenses compared to the rest of the neighborhoods by 100, 68 and 62 percent decline. The pattern emphasizes project frequency analysis findings about grouping neighborhoods into three classes (figure 24).

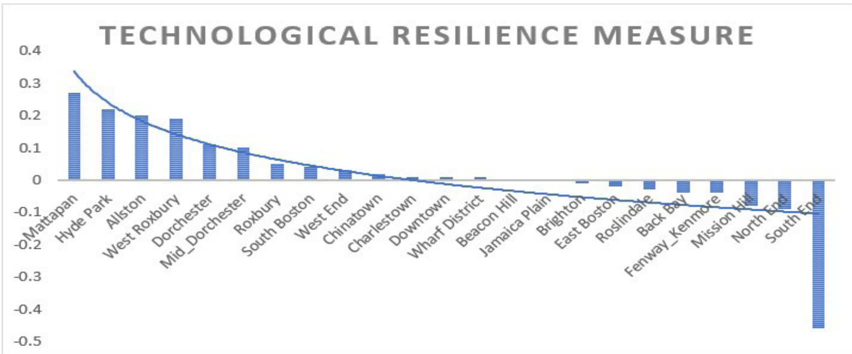

Figure 24 Technological Resilience Measure

Table 12 indicates the rate of investment evolution on Tech-related projects before and during the pandemic. Due to context-specific factors that will be explained later, the decline in preferences for investment in technology projects has varied among different groups of neighborhoods.

	Neighbourhood	Pre-pandemic 100 USD per Houses	Post-pandemic 100 USD per Houses	Change rate
1	Allston	0.95	0.99	0.04
2	Back Bay	8.69	5.28	-0.39
3	Beacon Hill	5.24	2.59	-0.51
4	Brighton	1.02	0.85	-0.17
5	Charlestown	1.25	0.64	-0.49
6	Chinatown	14.34	5.4	-0.62
7	Dorchester	1.58	1.48	-0.06
8	Downtown	6.37	3.74	-0.41
9	East Boston	2.06	1.13	-0.45
10	Fenway_Kenmore	11.81	5.59	-0.53
11	Hyde Park	2.4	2.27	-0.05
12	Jamaica Plain	1.35	0.92	-0.32
13	Mattapan	2.55	2.76	0.08
14	Mid_dorchester	1.11	1.07	-0.04
15	Mission Hill	1.87	0.83	-0.56
16	North End	0.67	0.27	-0.6
17	Roslindale	2.07	0.92	-0.56
18	Roxbury	1.8	1.49	-0.17
19	South Boston	5.83	3.54	-0.39
20	South End	0.14	0	-1
21	West End	13.24	9.23	-0.3
22	West Roxbury	1.15	1.12	-0.03
23	Wharf District	24.92	7.85	-0.68

Table 12.Boston's Neighborhoods and Change Rate in Green Tech related investment

5.1 Inequities in Green Transition

In the next paragraph, we will explore a mathematical model to work on the context-based indicators to find an appropriate regression line. After combining socio-economic factors of Boston neighborhoods generated from Census.gov & Analyze Boston platform (the City of Boston's open data hub to find facts, figures, and maps related to our lives within the city), we decided to elaborate on three pillars of indicators as mentioned before. Social factors include school attainment, age, race, and educational degree. The next pillar is dedicated to exploring the economics of people, such as median income, median house price, and poverty rate. The last pillar of the data set investigates the physical properties such as the ratio of vacant houses, poverty rate per neighborhood, and race proportion.

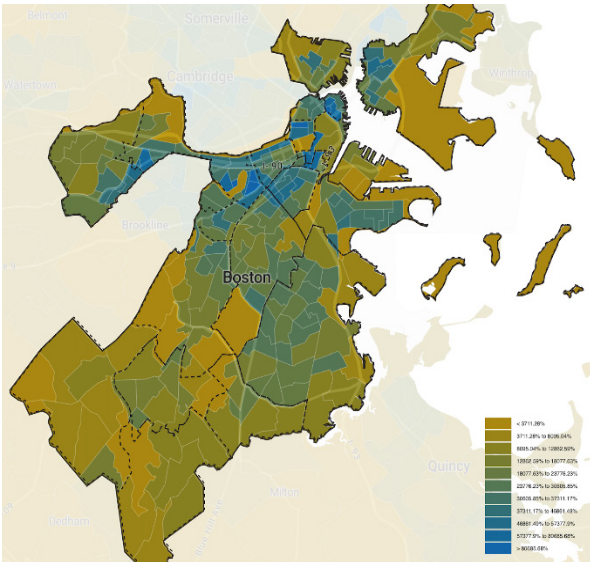

Figure 25. Boston's Neighborhoods Population Density

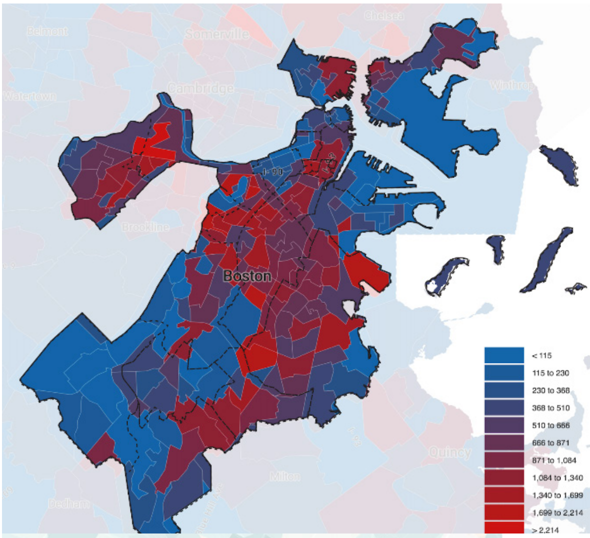

Figure 26. Boston's Neighborhoods Population Density

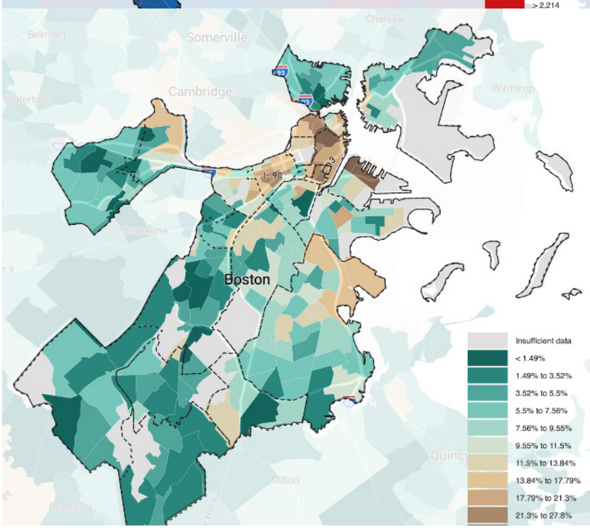

Figure 27 Boston's Vacant Units

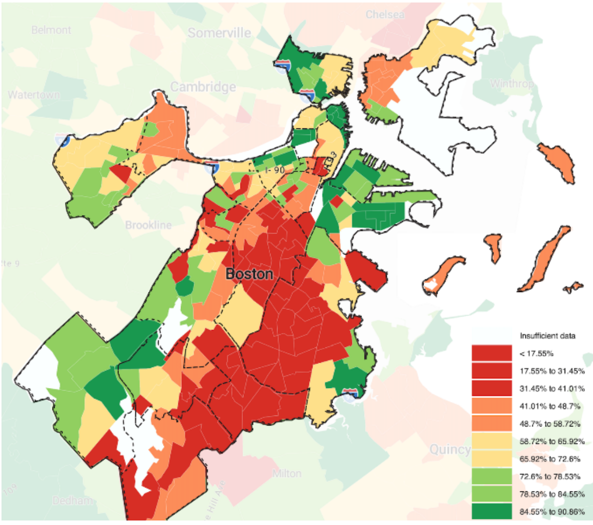

Figure 28 Boston's Predominantly White Neighborhoods

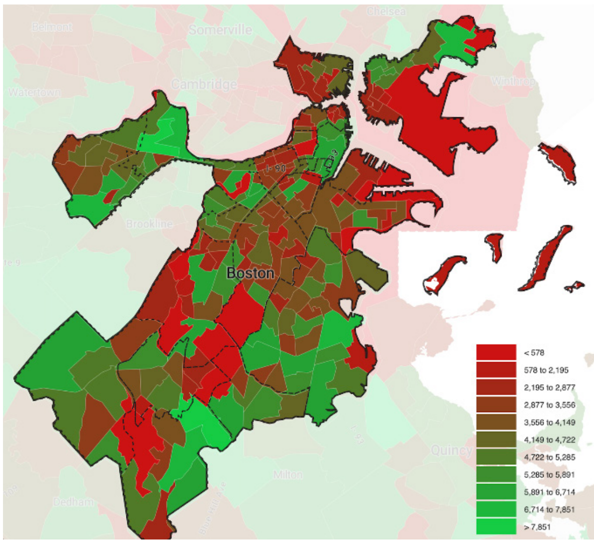

Figure 29 Boston's Number of Families

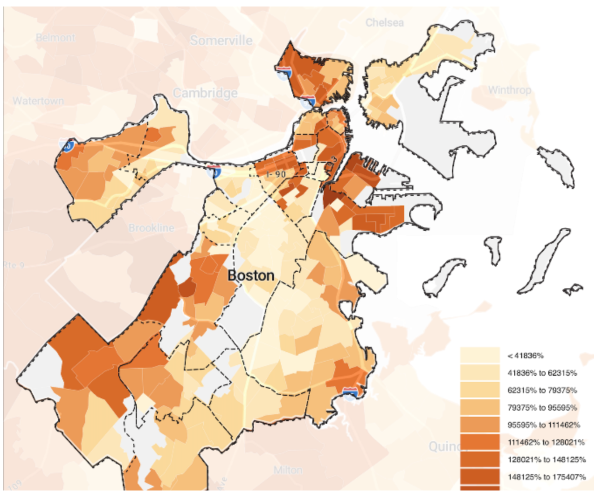

Figure 30 Boston's Median Household Income

All in all, running an iterative multivariate regression leads us to table 4 data, which describes why investment criteria vary among neighborhoods. Table 4 is a merged index that shows how the model works in three different periods by comparing the so-called "100 USD per House" expenditure on tech-related projects, summoned by three pillars. As illustrated, in the pre-pandemic period, the multivariate regression (MVR) model held an 82% R-squared which we can interpret as a relatively significant number of observations explained by this model. Considering that the significance F in the pre-pandemic period is 0.001, we are able to consider the model relevant to the proposed hypothesis. In this way, we will be able to establish a meaningful relationship between the technological expenditure and three pillars of indicators. The most significant coefficient is for the "vacant unit ratio" which is 81.755, that explains how neighborhoods with a larger ratio of isolated buildings have a propensity to invest in tech-related projects. There is a negative 27,150 correlation between poverty rate and investment, which indicates the reverse relationship between these socio-economic factors. While the number of families and median age have relevant P-values, the coefficients are relatively small. The model is as follows:

Y = 81.755(vacant units ratio) + 0.6613(median age) - 27.65(poverty rate) - 0.003(no. of families)

Table 13. Regression Coefficients and P-values

Pre-Pandemic				*Post-Pandemic*			*Pre-Post change*		
R Square	0.826146821			0.679134786			0.763318434		
Significance F	*0.001086511*			*0.033345573*			*0.006418594*		
	Coefficients	*P-value*		*Coefficients*	*P-value*		*Coefficients*	*P-value*	
Vacant Units Ratio	81.7552	0.0016	*	32.1304	0.0157	*	43.7726	0.0135	*
White Ratio	-7.8836	0.1864		-4.0397	0.2241		-6.3106	0.1570	
Median age	0.6613	0.0445	*	0.3774	0.0398	*	0.1683	0.0407	*
Master degree ratio	-3.2727	0.5350		0.5240	0.8582		0.8115	0.8242	
Graduate ratio	-12.6381	0.2671		-1.6336	0.7931		-11.3157	0.1963	
Per capita Income	0.000003	0.9593		-0.000005	0.8903		0.000027	0.5980	
Poverty rate	-27.6500	0.0490	*	-6.5263	0.0466	*	-17.5702	0.0406	*
Population	0.0006	0.0088	*	0.0002	0.0458	*	0.0003	0.0401	*
No of Families	-0.0031	0.0046	*	-0.0012	0.0319	*	-0.0016	0.0352	*

Next, we explore the post-pandemic period. We see that the R-squared and significance F are 67% and 0.033, respectively (See table 13). On the one hand, we could observe the same model and relatively slight discrepancies in p-valves, but the coefficients are formed differently. It is interesting to note that we were able to clearly identify the minor vacant units ratio and poverty rate from the model, which gives us an indication for analyzing the model in a cross-validation format in order to find a more robust explanation for the variables. It is essential to shedding light on the proportion of coefficient formations in pre-pandemic and post-pandemic periods. For example, the falloff is more significant in the "Poverty rate" from -27.65 to

-6.52. Decreasing the share of the poverty-related recession could pave the way for new research on neighborhood clustering topics for understanding community-level programs that rendered this amount of resiliency.

$$Y = 32.13(\text{vacant units ratio}) + 0.377(\text{median age}) - 6.526(\text{poverty rate}) - 0.001(\text{no. of families})$$

In the last step of table 13, we look at the variables of MVR under the lens of transmutation in investment between pre-pandemic and post-pandemic to find out the most influencing variable in this before-after regression. At first glance, the same variables are considered significant but looking more in detail, we observed a more significant opposing footprint of poverty rate compared to post-pandemic analysis. Furthermore, we find out the "vacant unit ratio" is the most significant factor here, followed by the same pattern of median age & poverty rate.

$$Y = 43.772(\text{vacant units ratio}) + 0.168(\text{median age}) - 17.57(\text{poverty rate}) - 0.001(\text{no. of families})$$

Altogether, we mapped Boston city based on mentioned factors in figures 25 to 30 to see any spatial concentration. Surprisingly, figure 28 shows how the highest "vacant unit ratio" neighborhoods are concentrated in the Boston center area, historically known as the prosperous Boston district. Figure 27 shows turning to the "poverty rate" how Fenway_ Kenmore, Mission Hills, Roxbury, and Dorchester draw the poverty boundary as the second tier of Boston. These all figures galvanize the spatial concentration assumptions of the research.

6. Conclusion

First, we observed clustering phenomena by neighborhood's tendency on tech-related project continuation trend versus the permission of the general project requests among 23 Bostonian neighborhoods. This finding could reveal the disparity among districts in the same city regarding green transition. We tested this finding in the spatial context to perform an illustration of technological resilience mapping for policymakers.

Second, for neighborhood groups, we suggested a measure as "100 USD per unit of housing" spent on tech-related projects. In this way, we captured neighborhoods' size, population, and housing density pattern to find a uniform measure in comparing them. After drawing districts' behavior diagrams and their pre/post-pandemic observations, we noticed a pattern of transition among them; this leads us to conduct a model for this phenomenon. Finally, to allocate scalable weight to each independent factor, we ran an MVR model and discussed the findings above. Suggesting a model despite results guides us to characterize groups of variables; these suggested pillars of ingredients offer a perspective to qualitative research plans for conducting surveys within the suggested neighborhoods to enhance the pillars. We believe there is more room for investigating community-level priorities and opportunities due to the diversity of Boston. Exercising shock heat maps, known as resilience mapping, is a novel perspective in urban studies investigating the flexibility of communities facing acute turbulence.

Third, looking at the model and pillars of the suggested variable, we could conclude that race, despite of long history of being addressed as a discrimination factor, has no significant effect on this transition model. However, one could claim "poverty rate" and "white race ratio" have a collateral relationship; we could not find any in this paper. Racial disparity is known as a risk factor in most American resilience plans. However, in the technological resilience domain, this could be addressed differently due to the reasonably uniform access to federal and local government funds on tech-related projects in the housing field. Although the highest R-squared is below 85 percent, this range's consistency allows us to generalize these findings as a call to map the city based on more research-based factors. Enduring a most significant variable pattern with expenditure (specifically on tech-related) layers on a dashboard could lead the policymakers to design an appropriate real-time and place-based plan for communities to prioritize actions.

Fourth, the final maps are created to call for more attention on structurally weak neighborhoods by policymakers and the communities to think again. The acute shock of the Pandemic enhanced the transition in structural change level. This phenomenon addresses the socioeconomic disparity at the local level. As a team of researchers, we believe the so-called post-carbon transition could be implemented locally. While this micro-scale is obliged to follow global programming structures, the ability to reveal inclusive shifts is a nexus between actors and places. Finally, we suggest spatial network analysis approach for the next steps of this research question on technological resilience assessment by benefiting from a relatively long panel data analysis of neighborhood behavior (Bevilacqua et al., 2022). In this paper, we suggested an MVR Model test and demonstrated the hypothesis on the lack of inclusiveness of transition based on the spatial disparity between Bostonian neighborhoods. In this way, there were limitations on expanding the pillars to more flexible measures at the neighborhood level, which one can suggest as a novel perspective in big data for urban research.

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The authors declare no conflict of interest.

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Mapping connections between neighborhoods in terms of their social needs

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Abstract

History can be embedded in every neighborhood's boundary and characteristics. In spite of this, the behavior of the community may be different or similar to that of the other communities depending on their needs. An analysis of the connection between neighborhoods in the City of Boston was conducted using a four-fold methodology as part of this study. This method uses a mixture of PCA, K-means, precisely dynamic versions, association roles, and a network map to perform this analysis. Thus, the levels of participation within 23 neighborhoods are visualized as maps in order to give a better understanding of the levels of participation. The study also takes into account the co-occurrence of complaints/comments of residents regarding the same issue as evidence of a connection between the two issues. The article goes on to emphasize the fact that community relationships are derived from the needs of communities, regardless of their ethnicity or location. In the process, a series of maps are generated; these maps are the result of a system that collects real-time information from call centers that do not deal with emergencies. Using our study, policymakers can identify the primary connections between 23 neighborhoods. Using online data collection and extensive data analysis, clustering coefficients and degrees of centrality are significant factors in identifying members of groups and marking crucial nodes in the network of historical experiences. In this study, full-time serie of neighborhoods are explored in addition to geographical location in order to gain a deeper understanding of a node in the system. Lastly, we discussed the issue of intercity policy-making and network analysis and provided users with a set of images containing the most frequently visited neighborhoods. Authorities may consider considering other dimensions than the traditional ones regarding neighborhood development and addressing problems.

Keywords: neighbourhood-mapping; cluster analysis; participation; community behaviour; 311Boston.

1.Introduction

Most large cities have diverse populations and the neighbourhoods within them have diverse socioeconomic characteristics that may influence residents' needs (Odoi et al., 2005)we identify unique neighbourhood socioeconomic characteristics and classify the neighbourhoods based on these characteristics. Principal components analysis (PCA. Neighborhoods are where people live or work near each other, recognizing each other from the recurring proximity. Additionally, our neighbors are not just residents who share the same special geographical area but also include shop owners and their employees, in other words, people who frequently visit the neighborhood (Hannerz, 1980). Neighborhoods' activities and participation build connections even with neighborhoods that are not directly connected to them. Moreover, we believe that geographical characteristic is not the only determinant of closeness proximity. On the one hand, the affective attachment of residents to the neighborhood may vary based on the amount of time neighbors spend in the area, local facility usage, and/or demographic patterns (e.g., the number of children, non- working adults, and aged who live in a community). One the other hand, the intensity of the connection between neighborhoods depends on many factors. It includes geographical, physical, and social characteristics of the community. Therefore, taking into account the diverse characteristics of the different neighborhoods would ensure that policies are tailored to the unique needs of the local residents in each neighborhood.

Citizen participation in neighborhood activities and governance should always be central to the formation of an residents' character, the inculcation of traditional values, and the maintenance of freedom. The community behavior is influenced by several factors including but not limited to socioeconomic status, social networks, education, ethnicity, working conditions, physical environment, and health (Chavis & Wandersman, 2002). Moreover, great transparency will help in boosting citizen engagement and empowerment with the city they live in (Newcombe, 2014). Already cities like Boston have built mobile applications that allow residents to report problems and then track the status of that problem (Newcombe, 2014). For example, 311 system in the US is designed to create "the human touch of small-town life in the context of a vast metropolis" (Johnson, 2010). The 311 service was created to transfer and receive nonemergency calls coming into 911 systems. Nevertheless, "311 is now used for performance measurement, economic development and community engagement" (Newcombe, 2014). The system has grown to not only respond to complaints but to tackle urban problems before they get bigger.

The objective of this study is to use multivariate statistical techniques to identify the socioeconomic and demographic characteristics of neighbourhoods in the city of Boston and to classify the neighbourhoods based on similarities of these characteristics. Despite the availability of vast literature on community attachment and satisfaction and their association to community participation (Bernard, 2015; Morris & Gilchrist, 2011; Theodori, 2004), the linkage between these factors in different neighborhoods as not yet been clearly investigated. This study, therefore, will examine the connection between neighborhoods in the City of Boston based on their behavior and perceptions. To do this, we first categorize the data set generated on 311 call centers for neighborhood troubleshooting requests. This arrangement help understanding the most frequent coexistence of the neighborhoods together. The most relevant communities will connect each other and weighted on the degree and intensity of the connection in order to form a graph. Finally the graph will examined for revealing centrality measures on the Boston's' neighborhoods.

This paper develops a statistical method to map the city's neighborhoods based on the community behavior. It begins by analyzing 9 attributes classified by BARI, Examples of the indicators of those attributes are Custodianship, Engagement, PublicDenig, PrivateNeglect , Housing , UncivilUse, BigBuilding, Trash, and Graffiti. threshold analysis is then used to find associated groups of neighbourhoods. Next, cluster analysis is performed to group the variation in neighborhood form based on their similarity and dissimilarity within the predetermined set of dimensions. Finally, a network based results will demonstrate. Then the research conclude findings and explains the limitations.

1.1. Neighborhood's proximity

Defining neighbourhoods is challenging and they could be described based on different characteristics (Stanley et al., 2022). Neighbourhoods are often defined in terms of the area where people live and engage in activities (Shields & Wooden, 2003) or residents' proximity to public transport and to work also the walk distances to a range of service (Kress et al., 2020). Neighbourhood boundaries can be defined in an informal, formal, and analytical way (Martin, 1998). Boundaries and names are created differently by members of different social groups (May, 1996). Classification of informal neighborhoods may display many different scales, multiple names for the same location, overlapping neighborhoods and indeterminate boundaries (Campari, 1996). These neighbourhood concepts are subject to change over time but may become official through their adoption by city managers such as real estate agents and local planners. Official neighbourhood labelling happens when agencies like postal authorities and local governments impose boundaries to assign locations to identifiable geographical regions. Campari called these boundaries "administrative artifact boundaries" (Campari, 1996). The process of defining these boundaries is itself complex. The analytic neighbourhood identification likely does not take into account informal concepts of neighborhoods but is often reconstructed from formal geographic areas. However, in this study, we believe that neighbourhoods classifications should also reflect social and physical characteristics to some extent, but not readily correlate with informally or formally recognized neighbourhoods.

There are gaps in measuring, evaluating, and representing the proximity between neighbourhoods, and these gaps could have consequences for the success of smart growth. Thus, this paper offers statistical proximity between neighbourhoods. The characterises of places matters and shared characteristics would facilitate the way public authorities will deal with these places. It is necessary for the effective development and implementation of public policy. Design guidelines and initiatives should be defined and enforced according to the area's interest and needs rather than only to the neighborhoods' features.

1.2.Community behaviour

Citizens participating in the community development whether by participating in local community institutions and organizations or by reporting problems in the neighbourhoods is increasingly considered to be vital for effective urban service delivery (Rich, 1979). Though history, it has been a major method for improving the quality of the physical environment, enhancing urban services, solving problems in many fields such as health and crime (Chavis & Wandersman, 2002). Chavis and Wandersman claimed that there are three components which influence the individual's participation in the voluntary neighborhood development (Chavis & Wandersman, 2002). Those components are "the perception of the environment, one's social relations, and one's perceived control and empowerment within the community".

Community participation is a vital part of in any community development processes (Mansuri & Rao, 2013). Participating in solving community problems happens based on various factors such as the residents feeling of their locality, when they know that their reports will be addressed from the authorities (Dalton, 2017; Morris & Gilchrist, 2011)"page":"1–13","source":"Google Scholar","title":"Communities connected, inclusion, participation and common purpose","author":[{"family":"Morris","given":"David"},{"family":"Gilchrist","given":"Alison"}],"issued":{"date-parts":[["2011"]]}},"label":"page"}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"} . Therefore, it is important to understand which factors motivate residents participation (Gamo & Park, 2022). Scholars claimed that participation is conditioned by culture, politics and social structure (Mansuri & Rao, 2013). The different levels of attachment of residents to their community are factors for differences in community participation (Jennings & Krannich, 2013; Matarrita-Cascante et al., 2006; Sapoetra et al., 2019). Community satisfaction is also treated as a key variable influencing community participation (Grillo et al., 2010; Sánchez-Franco et al., 2012).

Other studies that emphasise individual-level socioeconomic variables identified gender, age, education, income, religious affiliation and length of residence as factors influencing community participation (Ayorekire et al., 2017; Filkins et al., 2000; Matarrita-Cascante et al., 2006; Sapoetra et al., 2019; Theodori, 2004). Additionally, civic participation stems from a sense of responsibility towards solving neighbourhood problems or improving its services for the whole community (Doolittle & Faul, 2013). If the residents have a sense of community that can have a catalytic effect on local action.

Methodology

Material

This research utilizes BARI survey material on 311 call centers at the census tract level, which is collected into a 9*2150 matrix of components. This data set was elaborated on in 2021 to capture the citizens' perceptions about their community. BARI, The Boston Area Research Initiative, seeks to spur original, cutting-edge research in the greater Boston area that advances urban scholarship and improves public policy and practice. BARI is an inter-university research partnership between Northeastern University and Harvard University in conjunction with the City of Boston. The mission of this institute, as stated on the official website is, relies on the three main pillars:

1. Research-policy partnerships take a cross-disciplinary, data-driven approach to address the opportunities and challenges facing the communities of greater Boston.
2. The Boston Data Portal and associated technologies make novel data sources accessible for research, policy, and practice for a wide range of levels of data literacy.
3. Educational programming brings the tools and skills for working with community-centered data to multiple audiences, from community members to high school classrooms to university students in both data science and non-data science programs.
4. Convening and supporting a thriving civic data community in greater Boston through an annual conference, seed grants for graduate student research, and workshops developing "civic research agendas." (BARI Official portal)

Method

1. To provide more interpretable results for this research, we transform the census tract level (CT) into 23 neighborhoods. This transformation utilizes the ArcGIS method to map the CTs first at the neighborhood boundary level. The most relevant Cts are allocated directly to neighboring names, while few boundaries include two or three CTs; in this case, the neighborhood with a higher level of the data registered in the ZIP code name on it has been

nominated as the CT holder; thus 96% of CTs are indeed named, and rest of 4% is approximately connected to the respective neighborhood.

2. To reduce the nine components of the 311 call centers to an accountable dimension, we employed the principal component analysis (PCA) algorithm on them. Reducing the number of variables of a data set naturally comes at the expense of accuracy, but the trick in dimensionality reduction is to trade a little accuracy for simplicity. This method is based on an eigenvector value detection process. At the same time, the covariance matrix calculation plays a significant role in selecting which component of the call center data could be considered as the power. Balance is selected as the second eigenvector value, and the rest seven components hold the principle weight of less than 10%—formula one shows how this step forms the complex dataset as interconnected value coordinates (Maćkiewicz & Ratajczak, 1993).

$$z = \frac{value - mean}{standard\ deviation}$$

Formula 1 principal component analysis (PCA)

3. Next step in this research methodology, we formed a cluster analysis based on the K means algorithm. This method can be defined as an effort to mark subsets in the data, namely data circles within the very same subset (cluster), as expected as very similar. In contrast, data points in different clusters are very different. In other words, we are trying to find the most homogeneous partitions where the highest similarity or lowest distance is addressed while the difference to other members is relatively apparent. For this reason, we applied the correlation distance method to respect the eigenvalues we have grasped in the previous step to cancel out as much as a similarity. This iterative process started with an arbitrary K value (number of the clusters), and employed the elbow method, and we tested the optimum value of the k for each year. This K value fluctuated between years, and the final result for each year K means the algorithm has been tested for the highest performance by the silhouette test method. Bellow, we explained a step-by-step method of K means clustering algorithm, K determination, and evaluation in mathematical terms.

K means cluster : The approach k means follows to solve the problem is called Expectation-Maximization.

$$J = \sum_{i=1}^{m} \sum_{k=1}^{k} w_{ik} \left\| x^i - \mu_k \right\|^2$$

Formula 2 Expectation-Maximization

where wik=1 for data point xi if it belongs to cluster k; otherwise, w_{ik}=0. Also, μ_k is the centroid of $x^{i's}$ cluster.

In other words, assign the data point xi to the closest cluster judged by its sum of squared distance from cluster's centroid.

K determination: The elbow method runs k-means clustering on the dataset for a range of values for k (say from 1-10) and then for each value of k computes an average score for all clusters. By default, the distortion score is computed, the sum of square distances from each point to its assigned center.

$$\frac{\vartheta J}{\vartheta w_{ik}} = \sum_{i=1}^{m} \sum_{k=1}^{K} ||x^i - \mu_k||^2 \Rightarrow w_{ik} = \begin{cases} 1 & if\ k + argmin_j\ ||x^i - \mu_j||^2 \\ & 0\ otherwise. \end{cases}$$

Formula 3 sum of squared distance

Performance analysis: Silhouette analysis can be used to determine the degree of separation between clusters. For each sample: Compute the average distance from all data points in the same cluster (a_i). Compute the average distance from all data points in the closest cluster (b_i). Compute the coefficient:

$$\frac{\boldsymbol{b^i}}{\boldsymbol{max(a^i, b^i)}} - \frac{\boldsymbol{a^i}}{\boldsymbol{max(a^i, b^i)}}$$

Formula 4 Silhouette analysis

For finding logical patterns between appropriate clusters from 2011-2020, the probability of coexistence of the neighborhood in a subset has been observed. A well-studied discipline in the business chapter is Association rule mining. This method is based on items in a duplicate transaction in a series of transactions at a particular time. Usually, this method is applied to find a meaningful pattern among purchases for online stores. In this way, items appear in the same subsets when the tendency for having them together is higher than average (support value). We in this research applied this method within each year clusters to map the neighborhoods that coexist together for ten years. We calculate the probability based on the density of the seeds and then compare them to the suggested threshold for the relevant significant level. (Minimum threshold determination method based on dataset characteristics in association rule mining). The explained method was permutated for the second step. As we will discuss over the resulting unit, this repetition two times made the distinction as clear as the third level considered as selection between a polarized probability (more than 85% to 15%). This method concludes in a proximity matrix where the probability of coexistence of any 23 neighborhoods to each other is reported. The formula of Association rule mining (see formula 5) and the threshold of selection by stress on the average probability (see formula 6) are reported below.

$$. Supp(A \rightarrow B) = |\{t \in D | A \cup B \subseteq t\}||D|$$

Formula 5 Association Rule support calculation formula

Where, Supp is the support value; A is the antecedent of the rule in the form of itemset; B is consequent in the form of itemset; t is a transaction containing A and B; D is the total transaction.

Where, Sup(d) = support value for an item; n(d) = number of occurrences for an item; |D| = total transaction; |N| = total item; U(d) = utility value for an item; Util(d) = utility and support value for an item; Avesup = Average utility of the item; Minsup = minimum threshold value (item density level).

$$3.2. Sup(d) = n(d) \ / \ |D|$$

$$3.3. Util(d) = Sup(d) \times U(d)$$

$$3.4. avesup = \frac{\sum Util(d)}{d} |N|$$

$$3.5. minsup = avesup \ / \ |D|$$

Formula 6 Threshold of member selection

4. The final step in this methodology relies on the network creation tool. We conceptualize the neighborhoods as nodes and the probability of the coexistence grasped in step 4 as line weight as a proxy for the connection repetition. The network is an undirected topology looking to the connection of communities based on the clusters of the 311-call center. After forming all ten networks, we calculated the betweenness centrality as an index for the node's importance and the clustering coefficient value as an index for the homogeneity level of the network. For visualization of mentioned graphs, we utilized Gephi as a calculation and rendering engine coupled with MS excel for adjacency matrix creation. Bellow, we printed the betweenness centrality measurements (See formula 7) and clustering coefficient (See formula 8).

4.1. suppose that $g_i(st)$ is the number of geodesic paths from vertex s to vertex t that pass through i, and suppose that nst is the total number of geodesic paths from s to t. Then, the betweenness of vertex i is

$$bi = \sum s < tgi(st)/nst(1/2)n(n-1),$$

Formula 7 Betweenness centrality measurements

where n is the total number of vertices in the network. difference of an additive constant in the values for bi (Newman, 2005).

4.2. Clustering coefficients (Masuda et al., 2018):

=

$$C_i^{wei,B} = \frac{1}{s_i(k_i-1)} \qquad \sum_{1 \leq j,l < N_{ROI}} \frac{w_{ij}+w_{jl}}{2} \; a_{ij}a_{il}a_{jl}$$

Formula 8 Clustering coefficient

Where si = $\sum_{j=1}^{N_{ROI}} w_{ij}$ is the node strength (i.e., weighted degree). It should be noted that $a_{ij}a_{il}a_{jl} = 1$ if and only if nodes I, j and l form a triangle in the unweighted network. $a_{ij}a_{il}a_{jl} = 0$ otherwise. The average of $C_i^{wei,B}$ over all nodes defines the global weighted clustering coefficient denoted by .

Results and findings

The first finding of this research is an answer to the demand for PCA analysis of Boston city at the neighborhood level. By generating table 1, we elaborate on nine essential characteristics of the Bostonian communities which reported to 311 centers. As illustrated, the Custodianship as a factor of citizen safety satisfaction varies from 1.52 in Beacon Hill, historically known as a well-served community, to -0.08 as a slight fraction below the 0-line advocates› non-satisfaction of Fenway Kenmore residents. Not surprisingly, this rank repeated for the Engagement component of the same neighborhood by -0.66 as the lowest community engagement compared to the 1 for West Roxbury, as recently known as an emerging prestige neighborhood of Boston. It is essential to mention the polarization behavior of engagement characters as there are five negative observations compared to 18 positives emphasizing on 1.66 range of disparity. Public-Denig is a factor of public authority changing power for the community. This inception of confidence for the resident for contacting 311 to solve their problems is collected as a survey after each call or application notification. While the range of mentioned factors is consistently positive, advocating a relatively promising image of public authorities for the resident›s Jamaica plain is the lowest reported. This neighborhood historically knows for immigrants and people of color area. As stated by the Boston resilience strategy, these target groups are mainly under the hardship of establishing the connection to the authorized due to language barriers or cultural differences. PrivateNeglect is a factor of the buildings, areas, or objects left untouched for a long time in the neighborhood, which is observed as neglected gray areas for the community. Usually, this factor comes from the notifications requested for collecting or reusing objects and areas. Mattapan, Mid-Dorchester, and Dorchester are considered the highest hosts of the mentioned circumstance. These neighborhoods hold a long history of gray areas and left-behind zone, which currently drive the attention of tremendous knowledge-intensive companies for investment and land use conversion. Mattapan, the highest PrivateNeglect host, is transforming into a biopharmaceutical hub of the eastern coast in the most southern part of Boston, benefiting from relatively large gray areas facilitated by commuter trains and highways. Housing complaints and neighborhood issues such as snowfalls are the most frequent reason 311›s notifications follow the same pattern as PrivaeNeglect we analysis this similarity base on housing issues are more frequently occurring in most ill-functioning areas of the city while these neighborhoods are holding a relatively fair score of engagement thus reporting issues are more likely to concentrate on. The financial districts and downtown area are considered well-served communities with a negative score for housing issues. More than that, the density of the living area in mentioned neighborhoods is in low fraction compared to the business land uses. UncivilUse is a legal term for utilizing facilities for illegal or non-appropriate functions. It is usually reported to 311 as a load neighbor, offensive for quite a period of a neighborhood, changing land use (especially from resident to business), or smuggling acts in public. Fenway_kenmore, West End, Jamaica Plain, and Charlestown are among the lowest scores in the Boston area. Issues, as stated earlier, are more frequent in communities with recent demographic changes, such as Fenway Kenmore hosting numerous international students due to affordable rent and Jamaica plain as one of the most diverse areas of Boston. West End has historically hosing pioneer and diverse communities known for LGBT+ friendly neighborhoods since 1960 and European immigrant host. BigBuilding is a factor of complaints for the high density, high-rise buildings reporting miss management. Most interestingly financial district (Wharf District) holds the lowest score. The area is carpeted with towers, business buildings, offices, and parking. This score demonstrates the low satisfaction of the residents and businesses located in the area due to low service infrastructure, especially on severe climate days. We discussed this score with a group of residents living in the area during the verbal interview, and the most repeated answer highlighted the traffic, elevators, and snow dumps. On the other hand, Allston has the highest score expectedly since the neighborhood is well served by community management building. Trash is a common issue in Downtown Boston, with the highest score in North End for her busiest food and beverage retails followed by the South End, Downtown, and China town. This neighborhood lack resident and most of the area is furnished for retail shops, dining areas, and small-medium business. The community level is disconnected; the most apparent indicator of this disunited phenomenon is trash collection issues.

Lastly, the Graffiti issue is considered a typical issue of Boston, and we find that neighborhood-level cant serves the best for this indicator since each neighborhood faces this issue but in some instances, specifically in miss-served spots. As we discussed earlier, the areas with a more significant proportion of diversity and multicultural residents are more evidence. However, well-served areas such as Brighton, Hyde Park, and the Downtown area also reported graffiti.

Table 14. 311 call center PCA in Neighborhood level Boston

Code	Neighbourh	Custodiansh	Engagement	PublicDenig	PrivateNeglect	Housing	UncivilUse	BigBuild	Trash	Graffiti
1	Brighton	0.26	0.23	0.28	0.29	0.24	0.23	0.05	0.25	0.14
2	Allston	0.07	-0.21	0.44	0.47	0.57	0.18	0.14	0.26	0.53
3	Fenway_Ke	-0.08	-0.66	0.21	-0.15	-0.12	-0.18	0.06	0.08	0.29
4	Back Bay	0.84	0.33	0.32	0.12	0.02	0.12	0.02	0.26	0.27
5	Beacon Hill	1.52	0.78	0.22	0.24	0.24	0.16	0.08	0.18	0.12
6	West End	0.42	-0.26	0.23	-0.14	-0.08	-0.12	-0.01	0.17	0.2
7	North End	0.83	0.4	0.39	0.05	-0.02	0.1	0.04	0.36	0.24
8	Downtown	0.92	0.3	0.34	0.1	0.06	0.13	0.01	0.3	0.21
9	Charlestow	0.4	0.27	0.18	0.02	-0.01	-0.01	0.04	0.17	0.1
11	South Bosto	0.26	0.13	0.12	0.09	0.01	0.05	-0.02	0.11	-0.02
11	South End	0.93	0.28	0.35	0.41	0.45	0.22	0.04	0.32	0.21
12	Wharf Distri	1.32	0.29	0.29	0.25	0.15	0.22	-0.1	0.23	0.22
13	Chinatown	0.64	-0.39	0.43	-0.04	-0.14	0.09	0.04	0.29	0.49
14	Roxbury	0.49	0.27	0.26	0.32	0.35	0.17	0.04	0.19	0.25
15	East Boston	0.09	-0.12	0.29	0.25	0.2	0.25	-0.01	0.24	0.27
16	Mission Hill	-0.01	-0.35	0.25	0.35	0.43	0.1	-0.02	0.15	0.33
17	Jamaica Plai	0.1	0.11	0.05	-0.09	-0.15	-0.02	-0.03	-0.01	0.11
18	Mid_Dorche	0.21	0.56	0.24	0.62	0.73	0.36	0.07	0.2	0.13
19	Dorchester	0.31	0.49	0.23	0.49	0.51	0.35	0.04	0.2	0.12
20	Mattapan	0.35	0.93	0.21	0.63	0.68	0.44	0.12	0.2	0.06
21	Roslindale	0.33	0.78	0.12	0.12	0.02	0.18	0.03	0.08	0.1
22	West Roxbu	0.5	1	0.14	0.13	0.01	0.18	0.02	0.13	0.05
23	Hyde Park	0.15	0.71	0.06	0.14	0.1	0.18	-0.01	0.05	0.01

As a result of applying the Elbow method to the (table 14) data, we find out that despite the homogenous distribution of the factor values across neighborhoods, the K value seems to fluctuate from neighborhood to neighborhood, as illustrated in table 3. The most significant separation occurred in 2019, a year prior to the pandemic, while the number of clusters declined to 2 in 2018 and 2020 as only a line of distinction between the two years. It is due to this variety of partitioning that the K means algorithm generates multiple clusters out of the data. There are clusters in the city with only one neighborhood in 2013, and we observed clusters with only one neighborhood in 2019, one of the highest levels of disparity in the city. It is essential to mention that these clusters are created based on the correlation distance measure. The center of each cluster has located at the farthest possible position from the rest, which means that in 2011 and 2018, when the 23-neighborhood divided into two and three clusters, respectively, the city experienced a significant polarization due to residents' social and physical complaints.

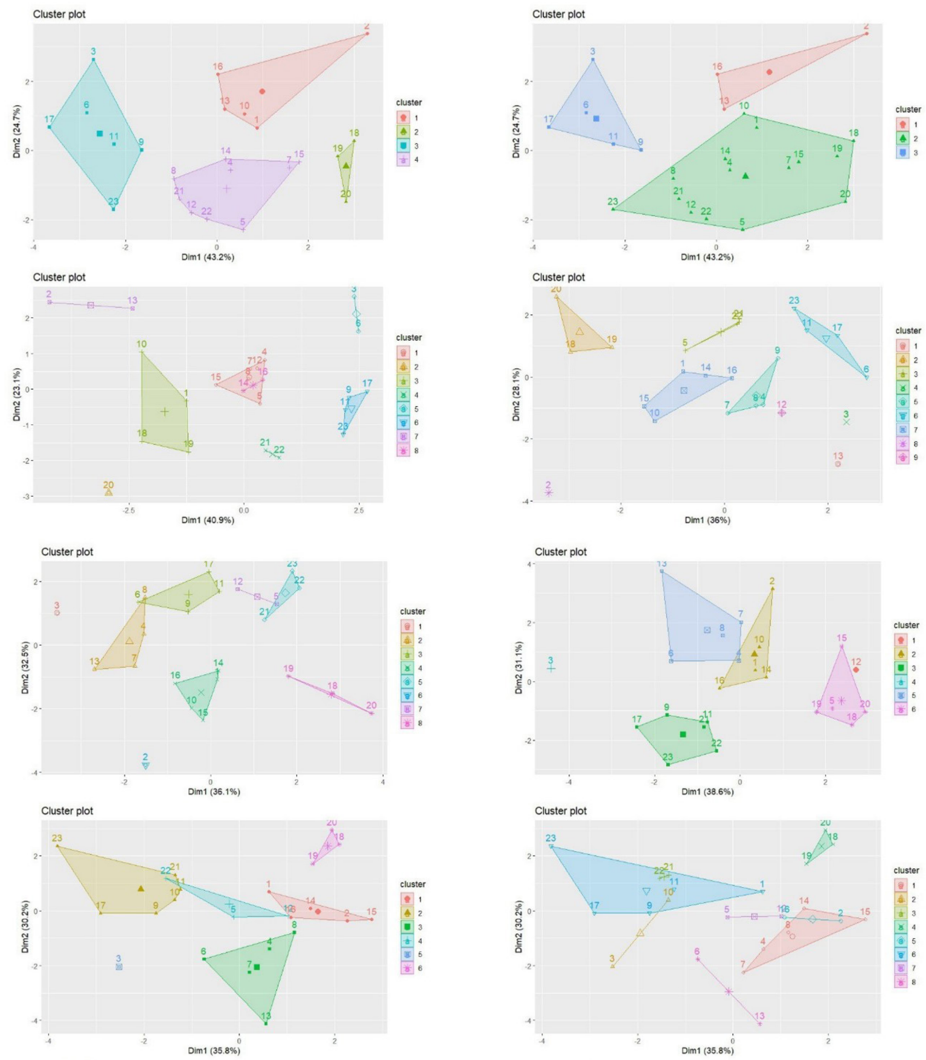


Figure 31 Eleven Years Optimum K for PCA on K means algorithm. Elbow method

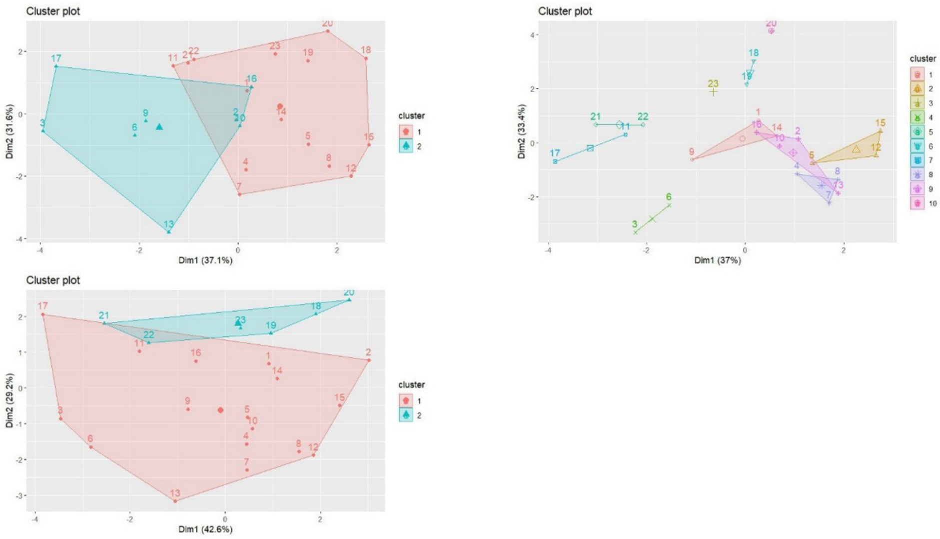
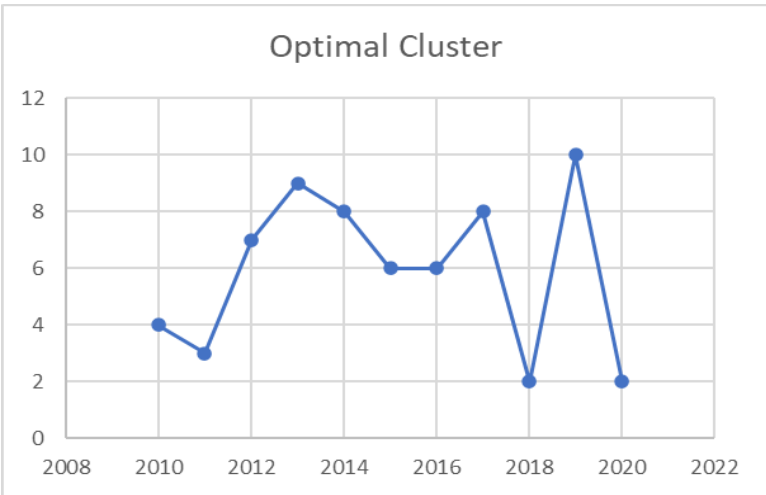


Table15.Boston Neighborhoods cluster based on PCA factors of 311. 2010-2020 (left to Right)



It is one of the objectives of this research to visualize clusters. Our method reveals clusters whose areas are two-fold larger than the rest of the illustration. Based on our analysis, large shape clusters (measured by area, not by number of members) are more likely to be interpreted as fragile. According to the silhouette method for performance assessment results, clusters with linear shapes score higher than those with large polygons. (See Figure 30).

In addition, cluster centers are determined by the weighted average distance between members. Essentially, in 2017 and 2019, we observed results with centers that were very close to each other, with eight and ten centers densely located, respectively. Conversely, in 2013, there were nine centers, and the distance was fairly normal. Based on the insulation specification, this specification is a technical innovation for evaluating clustering results.

As stated earlier, the clusters fluctuated during the ten years of the study;

thus, we utilized an association rule analysis to find out which neighborhoods are most likely to appear together during the mentioned period. For this reason, we conducted a permutation algorithm in which Table 4 illustrates the first layer of its results. Then, we applied the specified threshold explained in the methodology to explore the results more conclusive. Highlighted cells are the coexistence with relevant probability (more significant than the threshold) candidates for the second layer of the study. Table 16 First layer Association rule probability matrix

	Threshold																						
	0.37	0.1	0.08	0.35	0.27	0.14	0.34	0.38	0.21	0.27	0.29	0.25	0.13	0.35	0.39	0.16	0.2	0.14	0.18	0.14	0.21	0.16	0.18
Neighborhood	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
1	1.00	0.36	0.09	0.00	0.27	0.18	0.00	0.00	0.00	0.64	0.00	0.27	0.18	0.73	0.64	0.45	0.00	0.27	0.36	0.18	0.00	0.18	0.27
2	0.36	1.00	0.09	0.09	0.09	0.09	0.09	0.09	0.18	0.36	0.09	0.09	0.55	0.27	0.18	0.64	0.18	0.00	0.00	0.00	0.00	0.00	0.00
3	0.09	0.09	1.00	0.00	0.00	0.55	0.00	0.00	0.36	0.00	0.27	0.00	0.18	0.00	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.09	0.00	1.00	0.27	0.27	1.00	1.00	0.18	0.00	0.18	0.36	0.00	0.36	0.45	0.00	0.00	0.18	0.18	0.18	0.27	0.27	0.18
5	0.27	0.09	0.00	0.27	1.00	0.00	0.36	0.45	0.00	0.00	0.00	0.82	0.00	0.36	0.64	0.00	0.00	0.27	0.27	0.27	0.36	0.36	0.18
6	0.18	0.09	0.55	0.27	0.00	1.00	0.00	0.00	0.45	0.18	0.55	0.00	0.45	0.00	0.00	0.18	0.45	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.09	0.00	1.00	0.36	0.00	1.00	1.00	0.18	0.18	0.18	0.00	0.27	0.36	0.00	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.18
8	0.00	0.09	0.00	1.00	0.45	0.00	1.00	1.00	0.00	0.18	0.00	0.45	0.00	0.45	0.55	0.00	0.00	0.18	0.18	0.18	0.27	0.27	0.18
9	0.00	0.18	0.36	0.18	0.00	0.45	0.18	0.00	1.00	0.27	0.73	0.00	0.00	0.00	0.00	0.18	0.82	0.00	0.00	0.00	0.00	0.18	0.36
10	0.64	0.36	0.00	0.00	0.00	0.18	0.18	0.18	0.27	1.00	0.18	0.00	0.36	0.45	0.00	0.73	0.27	0.18	0.18	0.00	0.00	0.00	0.18
11	0.00	0.09	0.27	0.18	0.00	0.55	0.18	0.18	0.73	0.18	1.00	0.18	0.18	0.18	0.18	0.00	0.91	0.09	0.09	0.09	0.27	0.27	0.55
12	0.27	0.09	0.00	0.36	0.82	0.00	0.00	0.45	0.00	0.00	0.18	1.00	0.00	0.00	0.55	0.00	0.00	0.18	0.18	0.18	0.27	0.36	0.18
13	0.18	0.55	0.18	0.00	0.00	0.45	0.27	0.27	0.00	0.36	0.18	0.00	1.00	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.73	0.27	0.00	0.36	0.36	0.00	0.36	0.45	0.18	0.45	0.18	0.00	0.00	1.00	0.73	0.55	0.09	0.18	0.18	0.18	0.27	0.00	0.18
15	0.64	0.18	0.00	0.45	0.64	0.00	0.00	0.55	0.00	0.00	0.18	0.55	0.00	0.73	1.00	0.00	0.00	0.27	0.27	0.27	0.18	0.27	0.18
16	0.45	0.64	0.00	0.00	0.00	0.18	0.09	0.00	0.18	0.73	0.00	0.00	0.45	0.55	0.00	1.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.18	0.36	0.00	0.00	0.45	0.09	0.00	0.82	0.27	0.91	0.00	0.00	0.09	0.00	0.18	1.00	0.00	0.00	0.00	0.18	0.00	0.36
18	0.27	0.00	0.00	0.18	0.27	0.00	0.00	0.18	0.00	0.18	0.09	0.18	0.00	0.18	0.27	0.00	0.00	1.00	0.91	0.73	0.18	0.18	0.18
19	0.36	0.00	0.00	0.18	0.27	0.00	0.00	0.18	0.00	0.18	0.09	0.18	0.00	0.18	0.27	0.00	0.00	0.91	1.00	0.82	0.27	0.27	0.00
20	0.18	0.00	0.00	0.18	0.27	0.00	0.00	0.18	0.00	0.00	0.09	0.18	0.00	0.18	0.27	0.00	0.00	0.73	0.82	1.00	0.27	0.27	0.27
21	0.00	0.00	0.00	0.27	0.36	0.00	0.00	0.27	0.09	0.00	0.27	0.27	0.00	0.27	0.18	0.00	0.18	0.18	0.27	0.27	1.00	0.27	0.55
22	0.18	0.00	0.00	0.27	0.36	0.00	0.00	0.27	0.18	0.00	0.27	0.36	0.00	0.00	0.27	0.00	0.00	0.18	0.27	0.27	0.27	1.00	0.45
23	0.27	0.00	0.00	0.18	0.18	0.00	0.18	0.00	0.36	0.18	0.55	0.18	0.00	0.18	0.18	0.00	0.36	0.18	0.00	0.27	0.55	0.45	1.00

Table 16. Probability matrix at first level

Figure 31 shows the frequency for neighborhoods with relevant connections, and this analysis shows the pattern of the connectedness between areas of the city in terms of their community problems. As illustrated, neighborhoods 6 and 7 are the only areas that can interpret clearly as they appear in a few clusters with the same connections. However, the rest of the 21 neighborhoods have more than eight observed connections with higher than the threshold probability, making the conclusion vouge. For this reason, we conducted the second layer of the association rule algorithm by fixing two neighborhoods and permuting the rest of the relevant chances to find out if there is any probability of finding the relevant pattern. In the second layer, we find that the chance for coexistence is not a random connection, but specific neighborhoods connect conditionally. In table 6, we demonstrate the relevant seeds and subgroups.

Figure 31 Histogram for first layer connection probability

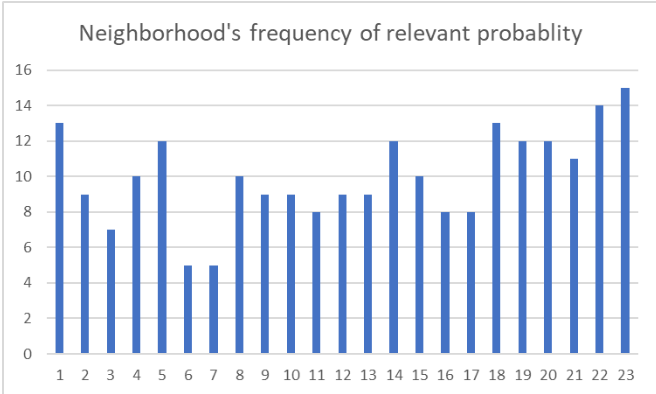


Table 17. Second Layer Association Rule probability

First layer			Seocnd Layer	Prob
Back Bay	North End	>>>	Downtown	1.00
Back Bay	Downtown	>>>	North End	1.00
Allston	Chinatown	>>>	Mission Hill	0.55
Back Bay	South End	>>>	North End	0.45
Back Bay	South End	>>>	West End	0.45
Beacon Hill	Wharf District	>>>	South End	0.66
Beacon Hill	South End	>>>	Wharf District	0.51
Beacon Hill	North End	>>>	Back Bay	0.45
Beacon Hill	North End	>>>	Downtown	0.45
Beacon Hill	North End	>>>	South End	0.45
Beacon Hill	North End	>>>	Wharf District	0.45
Beacon Hill	Downtown	>>>	Back Bay	0.45
Beacon Hill	Downtown	>>>	North End	0.45
Beacon Hill	Downtown	>>>	South End	0.45
Brighton	South End	>>>	Roxbury	0.64
Brighton	Roxbury	>>>	East Boston	0.55
Brighton	Roxbury	>>>	South End	0.55
Brighton	South End	>>>	East Boston	0.53
Brighton	Mission Hill	>>>	East Boston	0.46
Brighton	Mission Hill	>>>	Roxbury	0.46
Fenway_Kenmore	West End	>>>	Jamaica Plain	0.55
Jamaica Plain	Hyde Park	>>>	South Boston	0.45
Mattapan	West Roxbury	>>>	Mid_Dorchester	0.27
Mattapan	West Roxbury	>>>	Dorchester	0.27
Mattapan	West Roxbury	>>>	Roslindale	0.27
Mid_Dorchester	Mattapan	>>>	Dorchester	0.73

First layer			Seocnd Layer	Prob
Charlestown	South Boston	>>>	Hyde Park	0.73
Chinatown	Mission Hill	>>>	Allston	0.45
Dorchester	Mattapan	>>>	Mid_Dorchester	0.82
Downtown	South End	>>>	Back Bay	0.55
Downtown	South End	>>>	North End	0.55
Downtown	Wharf District	>>>	Back Bay	0.45
Downtown	Wharf District	>>>	Beacon Hill	0.45
Downtown	Wharf District	>>>	North End	0.45
Downtown	Wharf District	>>>	South End	0.45
Downtown	Roxbury	>>>	Back Bay	0.45
Downtown	Roxbury	>>>	North End	0.45
Downtown	Roxbury	>>>	South End	0.45
East Boston	Mission Hill	>>>	Brighton	0.46
East Boston	Roxbury	>>>	Brighton	0.45
Fenway_Kenmore	West End	>>>	Charlestown	0.55
Mattapan	West Roxbury	>>>	Hyde Park	0.27
Mattapan	Hyde Park	>>>	West Roxbury	0.27
Mattapan	Hyde Park	>>>	Mid_Dorchester	0.27
Mattapan	Hyde Park	>>>	Dorchester	0.27
Mattapan	Hyde Park	>>>	Roslindale	0.27
North End	Downtown	>>>	Back Bay	1.00
Roslindale	Back Bay	>>>	Beacon Hill	0.36
Roslindale	Back Bay	>>>	North End	0.36
Roslindale	Back Bay	>>>	Downtown	0.36
Roslindale	Back Bay	>>>	Wharf District	0.36
Roslindale	Back Bay	>>>	Roxbury	0.36

First layer			Seocnd Layer	Prob
Roslindal	Back Bay	>>>	South End	0.36
Roslindal	Back Bay	>>>	West Roxbury	0.36
Roxbury	Mission H	>>>	Brighton	0.55
South Bos	Jamaica Pl	>>>	Charlestown	0.81
South End	Mid_Dorc	>>>	Beacon Hill	0.27
South End	Mid_Dorc	>>>	Dorchester	0.27
South End	Mid_Dorc	>>>	Mattapan	0.27
South End	Dorcheste	>>>	Beacon Hill	0.27
South End	Dorcheste	>>>	Mid_Dorchester	0.27
South End	Dorcheste	>>>	Mattapan	0.27
South End	Mattapan	>>>	Beacon Hill	0.27
South End	Mattapan	>>>	Dorchester	0.27
South End	West Rox	>>>	Roxbury	0.27
South End	West Rox	>>>	North End	0.27
South End	West Rox	>>>	Back Bay	0.27
South End	West Rox	>>>	Downtown	0.27
South End	West Rox	>>>	Roslindale	0.27
South End	West Rox	>>>	Wharf District	0.27
South End	West Rox	>>>	Beacon Hill	0.27
West End	Charlesto	>>>	Jamaica Plain	0.45
West End	South Bos	>>>	Jamaica Plain	0.45
West End	Jamaica Pl	>>>	Charlestown	0.45
West End	Jamaica Pl	>>>	South Boston	0.45
West Rox	Hyde Park	>>>	Roslindale	0.45
Wharf Dis	South End	>>>	Back Bay	0.55
Wharf Dis	South End	>>>	Beacon Hill	0.55
Wharf Dis	South End	>>>	Downtown	0.55
Wharf Dis	South End	>>>	North End	0.55

Neighborhoods appear together in a rational pattern. We find that assuming two areas as Neighborhood 1 (N1) and Neighborhood 2 (N2), there comparable and calculatable chances for a third member of this subgroup as explained in table size. Although the call center contacts are arbitrary at first glance, the pattern for the coexistence of N1, N2, ..., and N23 are well structured. For example, assuming Back Bay and North End in a cluster, we find Downtown as the next cluster component defining the same applicable results. The last example is geographically proved since the three areas are connected in the Boston area. However, many examples of non-geographically proven connections lead researchers to draw the adjacency matrix for

the network illustration of the finding.
The first finding of the network study for the clusters of Boston shows that the network density is relative to expected (0.391) compared to the total number of nodes (23). As illustrated in table 7, Downtown, with 14 connections, is connected to almost 63% of its potential connections, which can interpret as common issues for this neighborhood among Boston area residents. Node's degrees are well distributed; however, the left skewness is observed. Compared to the standard urban network generated in logistics, economic and social connectedness, this arrangement is well describing a more significant neighborhood clustering tendency with the smaller. At the tail of this graph, we observe West End and North End neighborhoods. The degree of this area is proportional to the size of neighborhoods and their context. North End is concentrated on dining and beverage services and well prepared for retail services; thus, the resident's complaints have less in common with the rest of the city, followed by the West End district as the financial and accommodation services hub of Boston.

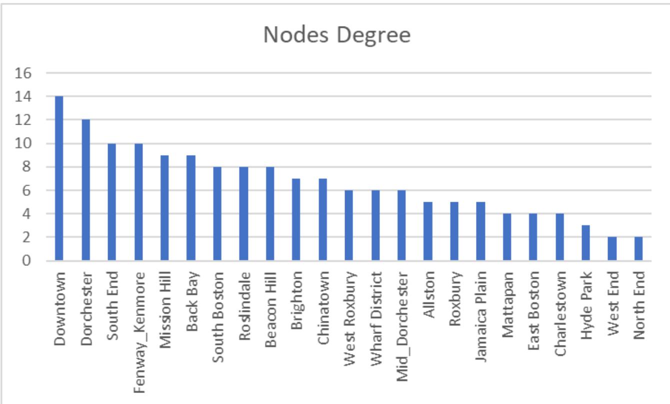
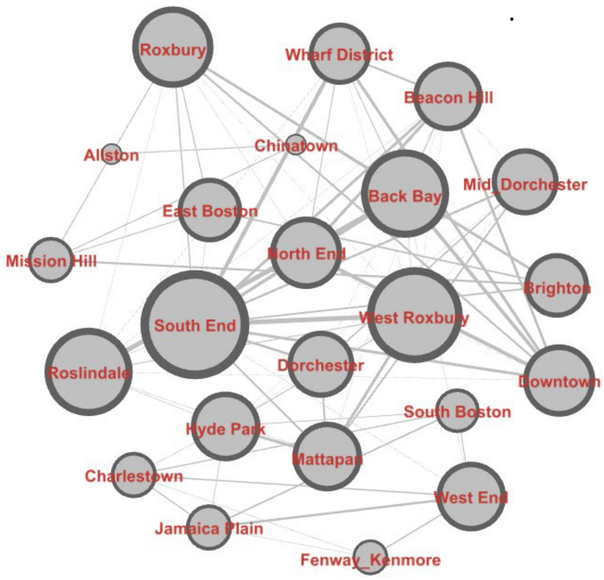


Figure 32 Nodes degree for connection Boston PCA network

By mapping the network under the lens of closeness centrality (Figure 32), we can see which neighborhoods are playing a central role in Boston. On the list, South End, West Roxbury, and Back Bay were ranked according to their closeness. Considering the analysis, this information can be translated into the primary resident hub for the location. The South End of Boston is a dominant residential area home to the BU medical campus, Northeastern university campus, and many residential complexes. A prominent voice for 311 is found here in the downtown area. As the network illustrates, West Roxbury is located at the southwestern border of Boston city and aims to advocate for the neighborhoods located west and south of the city; as the network demonstrates, we have grouped neighborhoods based on the issues they share with the rest of the city. It could be argued that each neighborhood's closeness can be viewed as a result of its central role in terms of its members of a standard cluster. It is historically known as the central hub of Boston, housing middle-class residents, and commuters from Massachusetts, and expected to play a central role in resolving typical problems. As the degree graph (Figure 33) proves the degree for this node is above average (9 > 6.8), the connections and centrality are explainable.

Figure 33 Neighborhoods nodes degree on 311 Network



Betweenness centrality typically measures the shortest path in the network; for this research context, this centrality measures the flow of the issues in the network. As illustrated in table 9, the South End, Mission Hill, Roxbury, and West End are the neighborhoods that contributed with 311 centers. Mentioned districts are the ones that connect the clusters during the ten years of the research period. In this research, we find that neighborhoods with high degrees cannot necessarily know their connectedness to the network or their central point for playing as the bridge. As the network shows, Downtown and Dorchester are relatively the most isolated neighborhoods in terms of 311 connection among the Bostonian areas. One more critical piece of information from table 9 is that the dominant nodes in Betweenness centrality are the neighborhoods ranked among the highest poverty rates based on the Boston Socioeconomic database. However, Allston, with a higher poverty rate than the South End, is not ranked as one of the central components.

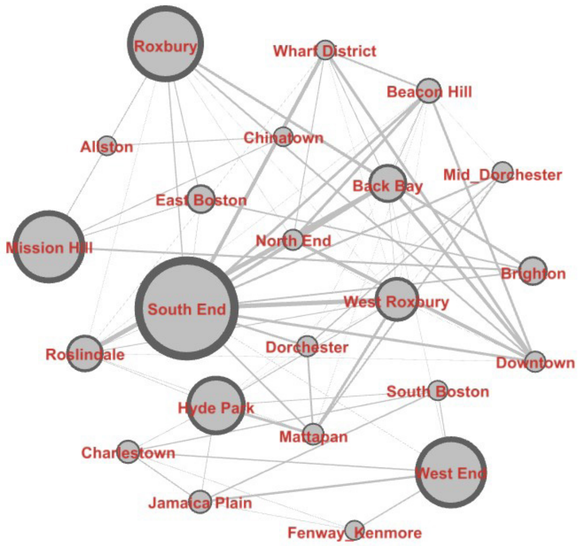


Figure 34 ***Closeness Centrality graph on 311 Network***

Conclusion and discussion

This research is conducted to grasp a methodology for looking at Bostonian neighborhoods as a case study for the community-level clustering practices in the academic domain. We proposed a How-to method for dealing with large data sets of non-emergency data sets to explore urban complexity under the lens of data-driven research. 311 is a center for residents to discuss their issues, physical disturbances, missed management, ill services, and, more often, to report a complaint. Looking at each notification as a link between authorities and the citizen can reinforce the resiliency of a city relying on diversification in the monitoring process. Resilience as a multilevel phenomenon technically depends on more swift responses to everyday stress becoming a chronic issue in each neighborhood. TREnD project as a European-funded program is aimed at reducing turbulence within communities to ensure cities' evolutionary transition path will be encouraged. For this goal, we studied a metropolitan case in the USA as a vast network of Neighborhoods, citizens, policymakers, and leaders to show the possible dashboard ideas as an add-on to the city monitoring plan.

PCA is a well-studied method for reduction, and the urban system is a complex network of agents and environments that cannot translate based on cause-and-effect phenomena. Thus the mode is encouraging for emphasizing on most dominant factors for the specific problem. In this research, We find limited studies explore the PCA method at the community level. None of them looked at urban settings as a system but often at physical levels or economic chains. We are calling for more research on the PCA method for the city's social component. The best evaluation, visualization, and theoretical framework for the results require more detailed attention. For the purpose of this study, we extensively relied on mathematical literature on data science, business literature on transaction analysis, and network studies for social interaction. The Association rule, which is implied essentially in this research, has potential for utilization of logistic data most likely to traffic algorithm for suggesting the congestion, ill-connected services, and homogeneity at a neighborhood level on social interactions.

The network model is a cornerstone of this research results both as visualization of the results and statistical analysis. In the initial steps, we conduct all levels of the research at the CTs, and the following limitations lead us to transform to a higher level of granularity. However, Boston has 2144 CTs which is very comfortable for network modeling, and the statistical results can interpret easier; clustering algorithms for several such points with relatively close proximity for both Euclidean distance and correlation distance turn the result nonconclusive. We suggest that authorities at 311 collect more variables on each notification for possible elaboration on the PCA method and, consequently, wider intervals for clustering algorithms. This research applies to the regional level; however, we believe pushing limitations towards lower granularities could lead policymakers to have valuable data on the similarities between neighborhoods and communities. Legislations are routinely set at the neighborhood level, if not the city level. We are encouraging our fellow researchers to generate as much information as possible to address better people's demands at the community level.

Results of this study could elaborate on dashboards evaluating city performance and resilience indexes of the neighborhoods. We believe constant monitoring of such algorithms at the community level could result in based resilience strategies suggested and tailored to their very own demands. Geography is relevant as well as social connection. This research reveals the level of connectedness between routinely known unrelated neighborhoods. For example, there are some issues in South End and West Roxbury; people are paying the same attention to a problem as a community issue that can be explicitly addressed. This way, the same clustered neighborhoods can be monitored together, and further action can be taken in advance. An increasing number of complaints in a cluster or, more precisely, in the central neighborhoods can signal to authorities that a common problem affecting many different neighborhoods can increase the effectiveness of the response. As urban areas are experiencing such a level of shocks and stresses, even a one-size-fits-all action plan is not feasible, whether at the regional (metropolitan) or city levels; therefore, these studies are designed to shed light on the call center's ability to not only act as a bridge between residents and authorities but also serve as primitive platforms that suggest better solutions for problems.

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The authors declare no conflict of interest.

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Conclusion of research project

The focus of this thesis was the management of a unique transition process within a city. Researchers have previously written about city transition (Chick & Meleis, 1986; Anderson et al., 2011; Bulkeley et al., 2011; Barclay, 2017) using the methods introduced by the researcher. The topic of transition, evolutionary process, and resilience was discussed in detail. These processes are all interconnected within this thesis' chain of thought units. A true transitional evolutionary development was the direction of this thesis. There was a particular focus on exploratory methodology, which was used to explore the existing data to gain a deeper understanding of the transition process. In our study, we examined the theories of economists, geographers, city theorists, and public policymakers (Becker & Karplus, 1997; Arthur, 1999; Coenen & Truffer, 2012; Balland et al., 2015; Barclay, 2017; Armondi, 2020; Hassankhani et al., 2021). To better illustrate the management steps, we examine the city identity through an evolutionary lens in this thesis. For sustainable development in an urban context, the research team introduced various tools such as network outlook, network drawing, economic clusters, and urban resilience. The purpose of this thesis was to provide policymakers and researchers in the field with a deeper understanding of how to use data, techniques, and theories effectively. This thesis begins by describing how to introduce a complex system (Foote, 2007; Ladyman et al., 2013) in the form of a network, how it evolves, and how it can be assessed. In addition, we used the printed paper of the research team to introduce our theoretical data as well as results generated with analysis and elaborate on the context details. Detailed explanations of network theory will be provided in the in second chapter, afterward, we discussed its mathematical and statistical principles. We were able to connect the economic network clusters and their traces in the European regional union through a creative method. Cohesion policies have been implemented in different ways for many years. As a result of these processes, convergence methods were introduced, and different regions of the European Union were addressed. Throughout this thesis, we have attempted to investigate how the cohesion policies can introduce the cohesion policies planning of the new era more efficiently by changing their view of just economics or geography to an in-network evolutionary view. Our thesis was augmented by two biological studies; the first was the hamming distance (Berger et al., 2020; Chookajorn, 2020; Furubayashi et al., 2020), which was used to measure the distance between cities in terms of economic clusters as the first step in understanding the city identity.

The second was endosymbiosis (Chang et al., 2021; Gray, 2017) , which describes a kind of symbiosis between the economic network within the city network. In addition, we demonstrated that this theory could be applied in practice and be practical by including the research results of our co-researchers in the Calabria region network modeling. In the third section, we discuss city resilience as a practical aspect of transition in shaping city identity. In order to develop a resilience assessment index, we used Boston as a forerunner American city. Two projects were introduced as part of this proposed index. The first one measured the amount of investment and permission each neighborhood had to use new technologies regarding climate change before and during the pandemic. In the second one, neighborhoods were connected to the 311 networks, and a new network was created based on the behavior of each neighborhood. The development of this assessment index for technological resilience will assist other researchers and us in the future in contributing to resilience assessment, specifically in technological resilience assessment. We discussed how to separate and make connections purposefully within different city neighborhoods using a non-emergency network known as 311. In each of these chapters, there was an introduction to a theory, a test of the theory in a context, and a report of the findings. For the next step in this study, we determined that conceptual frameworks in evolution theory are necessary for controlling this project and developing science in managing city transition. With evolutionary theory being applied in the urban field with a biological perspective, combining biological science, urban development science, and geographic science may produce a new discipline in urban life. In this discipline, new cells, new cell cores, and even a pioneering method of urban cell reproduction may be described. As a result of considering a city from an evolutionary biology perspective, we can borrow various biological terms and processes and use them in an urban environment where humans play a major role, where migration is more important than reproduction, and where processes such as natural selection and mutation take place within a large ecosystem that is operated like a separate island connected to different networks. In addition, network theories should be combined with resilience theory. As a result of our use of terms such as robustness, interconnectedness, and diversification, which are terms used interchangeably in resilience and network studies, resilience has a tendency to be networked. Based on networks, the lost chain can be used to draw and interpret urban space, urban transition, and urban resilience. The city can be divided into layers of networks using a scientific framework, and the connections between the layers of networks are based on different aspects of human life. We believe that there is a lack of strong framework theories and analytics activities in the field. Despite the fact that the network has had a great deal of activity in the physical environment of a city, it has yet to mature in terms of its social and economic aspects. The process we used to solve the environmental crisis, and climate change crisis involved connecting the economic networks of cities within a region and using the city-region and region-human viewpoints. It is an endogenous cycle between city physics, city society, and city economics. A better understanding of technological resilience is the next step that can be taken. Our field did not have a great deal of good literature on technological resilience. Several authors have described technological resilience as the ability of a region to attract and maintain technological development. It has been paired with technology resilience in some literature, but these concepts are completely different. Through a data-driven methodology, we have attempted to identify connections between performance on a community or neighborhood scale and contribute to technological resilience. According to the researcher, this process can serve as a starting point for future research and development in the field of technology, as well as allowing all technologies, including construction technologies, mass communications technologies, infrastructures, and government technologies, to be evaluated in relation to various shocks and stresses and obtain a more accurate assessment. In general, after describing the three steps, what finishes this paper is introducing a method for developing the process of city transition using data better and interdisciplinary sciences; as a result, different experts from different fields are working together to address a new crisis humans face in their new habitat, the city. For three years, this thesis worked on putting into practice the suggestions of experts in a variety of fields facing city crises. The models produced, however, were unsuccessful due to the researcher's lack of theoretical ability to interpret the answers of models utilizing different types of literature, or they were unable to complete and describe the transition from one city to another. This research domain's limitations were based on the data, exploration algorithm, and a bold theoretical framework. The study domain lacks a biological perspective; the engineering perspective on urban regeneration is ill-equipped for the evolutionary transition process happening in the cityscape. Data on the urban level is rarely collected for transition purposes but more often for logistics or surveillance; however, the transition management requires community data gathering.

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