



The impact of covid-19 on housing affordability indexes Grenoble, France : a case study

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Grenoble Alpes University
Institute of Urban Planning and Alpine Geography
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**THE IMPACT OF COVID-19 ON HOUSING AFFORDABILITY INDEXES
GRENOBLE, FRANCE: A CASE STUDY**

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2021

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LIST OF ABBREVIATIONS

2019-nCoV	2019-new Corona Virus
AEDES	Association of Housing Corporations, Netherlands
CLC	Corine Land Cover
COVID-19	Corona Virus disease - 19
CPI	Consumer Price Index
DAC	Development Co-operation Directorate
ECDC	Centre for Disease Prevention and Control
ECRI	The European Credit Research Institute
EPL	Entreprises Publiques Locale - Local Public Companies
ESH	Entreprises Sociales pour l'Habitat - Social Enterprises for Housing
EU	European Union
EU-SILC	EU Statistics on Income and Living Conditions
GAM	Grenoble-Alpes Métropole
GDI	Gross Disposable Income
GDP	gross domestic product
GIS	Geographic Information System
GOS	Gross Operating Surplus
HLM	Habitation à Loyer Modéré - low-income housing
INSEE	The National Institute of Statistics and Economic Studies
MDGs	Millennium Development Goals
MERS	Middle East Respiratory Syndrome
MHCLG	Ministry of Housing, Communities & Local Government, UK
OECD	The Organization for Economic Co-operation and Development
OLL	Observatoire local des Loyer - Local Rent Observatory
OPH	Offices Publiques de l'Habitat - Public Housing Offices
PHEIC	Public Health Emergency of International Concern
PHS	Pôle habitat social
PIM	Pandemic Impacts Measurement
QGIS	Quantum Geographical Information System
SARS	Severe Acute Respiratory Syndrome
SARS-CoV-2	Severe Acute Respiratory Syndrome - Corona Virus 2
UN	United Nations
UN SDG's	United Nations Sustainable Development Goals
USH	L'Union sociale pour l'habitat - The Social Union for Housing
WHO	World Health Organization

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ABSTRACT

On 30 January 2020, the World Health Organisation (WHO) declared that the outbreak of COVID-19 constituted a public health emergency of international concern. Less than two months later, on 11 March 2020, WHO announced that the outbreak had developed into an international pandemic and that the COVID-19 virus is highly contagious to humans. Preventative acts were set in place; some countries went into full isolation and virtually all businesses were closed. The impact of the pandemic manifested almost immediately on several levels. Some of these were expected, such as its effect on healthcare and the economy. Other effects, such as the pandemic's impact on housing affordability, however, took longer to surface.

Soon after the outbreak of COVID-19, scholars of housing began measuring its impact on housing. Several reports and studies were published, most notably "The State of Housing in Europe 2020," and "Housing Europe's Annual Report, 2021." Despite early success in identifying the effect of the pandemic on housing affordability, there remains no systematic method to assess housing affordability indexes. Additionally, most studies on the relationship between pandemics and housing affordability focus on vulnerable groups rather than society in general.

Consequently, this thesis seeks to answer the following questions: What affordability indexes are related to COVID-19? What are COVID-19's direct and indirect effects on housing affordability? How should the pandemic's impact on housing affordability be assessed? And what lessons can we learn from the COVID-19 outbreak to ease the impact of similar pandemics in the future? By addressing these questions, this thesis works to establish a foundational understanding of the relationship between the pandemic and housing affordability. Put more simply, it investigates COVID-19's impact on housing affordability indicators in the long term and the short term. Additionally, it brings together the different approaches, methods, and indexes used to study housing affordability in an effort to create a systematic framework that can be employed when specific conditions are met such as data availability, time and location of the study.

This thesis uses both qualitative and quantitative methods to investigate and analyse the relationship between the pandemic and housing affordability; it identifies commonly used definitions and approaches and examines various indexes including the state of the housing market (income and cost), housing provisions (new and existing), and the social composition of the housing landscape. While a set of qualitative tools were deployed to develop the theoretical base of this study, quantitative tools were used to form a systemic assessment framework. Both tools were used to conduct a systematic analysis of the study location on a national scale (the French Republic) and on a communal scale (the city of Grenoble).

The outcome of this investigation has been formulated as a theoretical database that defines, describes, and explains pandemics, housing affordability, and the associated costs of pandemics on

housing affordability indexes. In addition, a systematic framework has been developed to clarify the methods used to measure the effects of the pandemic on housing affordability in Grenoble, France. More broadly, this thesis aims to bridge the gap in the extant literature and pave the way for future research on COVID-19's impact on housing affordability and on the methods used to measure the negative costs associated with pandemics.

Keywords: housing affordability indexes, COVID-19 impacts, Grenoble.

RÉSUMÉ

Le 30 janvier 2020, l'Organisation mondiale de la santé (OMS) a déclaré que l'épidémie de COVID-19 constituait une urgence de santé publique de portée internationale. Moins de deux mois plus tard, le 11 mars 2020, l'OMS a annoncé que l'épidémie s'était transformée en pandémie internationale et que le virus COVID-19 était hautement contagieux pour l'homme. Des mesures préventives ont été mises en place ; certains pays se sont mis en isolement total et pratiquement toutes les entreprises ont été fermées. L'impact de la pandémie s'est manifesté presque immédiatement à plusieurs niveaux. Certains d'entre eux étaient attendus, comme son effet sur les soins de santé et l'économie. D'autres effets, comme l'impact de la pandémie sur l'accessibilité au logement, ont toutefois mis plus de temps à se manifester.

Peu après l'apparition du COVID-19, les spécialistes du logement ont commencé à mesurer son impact sur le logement. Plusieurs rapports et études ont été publiés, notamment "The State of Housing in Europe 2020" et "Housing Europe's Annual Report, 2021". Malgré les premiers succès obtenus dans l'identification de l'effet de la pandémie sur l'accessibilité au logement, il n'existe toujours pas de méthode systématique pour évaluer les indices d'accessibilité au logement. En outre, la plupart des études sur la relation entre les pandémies et l'accessibilité au logement se concentrent sur les groupes vulnérables plutôt que sur la société en général.

Par conséquent, cette thèse cherche à répondre aux questions suivantes : Quels indices d'accessibilité au logement sont liés à COVID-19 ? Quels sont les effets directs et indirects de COVID-19 sur l'accessibilité au logement ? Comment évaluer l'impact de la pandémie sur l'accessibilité au logement ? Et quelles leçons pouvons-nous tirer de l'épidémie COVID-19 pour atténuer l'impact de pandémies similaires à l'avenir ? En répondant à ces questions, cette thèse vise à établir une compréhension fondamentale de la relation entre la pandémie et l'accessibilité au logement. Plus simplement, elle étudie l'impact du COVID-19 sur les indicateurs d'accessibilité au logement à long terme et à court terme. En outre, elle rassemble les différentes approches, méthodes et indices utilisés pour étudier l'accessibilité au logement dans le but de créer un cadre systématique qui peut être utilisé lorsque des conditions spécifiques sont réunies, telles que la disponibilité des données, le moment et le lieu de l'étude.

Cette thèse utilise des méthodes qualitatives et quantitatives pour étudier et analyser la relation entre la pandémie et l'accessibilité au logement ; elle identifie les définitions et les approches communément utilisées et examine divers indices, notamment l'état du marché du logement (revenu et coût), les dispositions en matière de logement (nouveau et existant) et la composition sociale du paysage du logement. Alors qu'un ensemble d'outils qualitatifs a été déployé pour développer la base théorique de cette étude, des outils quantitatifs ont été utilisés pour former un cadre d'évaluation systémique. Les deux outils ont été utilisés pour mener une analyse systématique du lieu d'étude à l'échelle nationale (la

République française) et à l'échelle communale (la ville de Grenoble).

Le résultat de cette enquête a été formulé sous la forme d'une base de données théorique qui définit, décrit et explique les pandémies, l'accessibilité au logement et les coûts associés aux pandémies sur les indices d'accessibilité au logement. En outre, un cadre systématique a été développé pour clarifier les méthodes utilisées pour mesurer les effets de la pandémie sur l'accessibilité au logement à Grenoble, France. Plus largement, cette thèse vise à combler les lacunes de la littérature existante et à ouvrir la voie à de futures recherches sur l'impact de COVID-19 sur l'accessibilité au logement et sur les méthodes utilisées pour mesurer les coûts négatifs associés aux pandémies.

Mots clés : indices d'accessibilité au logement, impacts de COVID-19, Grenoble.

CHAPTER 1: INTRODUCTION

Establishing the motives for this study is important for understanding the outcomes and arguments found within it. Broadly speaking, this thesis addresses the pandemic's (specifically COVID-19's) impact on housing. More specifically, it examines how the pandemic affects the affordability of housing through the aspects involved in housing provisions, and the methods for measuring the associated impacts of pandemics, to better understand the connections between pandemics and the housing affordability aspects. It aims to form a unified method of measurement that may help to estimate the impacts of pandemics on housing affordability aligned with the fact that, estimating an impact is the first step toward the resolution of the problem, expand current knowledge, and pave the way for future research.

Housing, and especially housing affordability, is a global challenge that receives significant of attention and focus (Preece et al., 2020, Wetzstein, 2017). This may lead to the belief that housing problems are easily addressed and that housing conditions must be improving rapidly. But recent reports and studies suggest that the opposite is true (Kallergis et al., 2018). Many European countries are suffering from housing affordability issues that are quickly worsening and are already influencing many aspects of their inhabitants' lives, both politically and economically (DESA, 2020, Wetzstein, 2017). At the same time, understanding housing affordability and its variables is challenging, especially because these encompass several fields of study including engineering, politics, and the social sciences. As such, the question of housing affordability has long been disputed and has led to the creation of several theories, methods, and tools to address it.

During the last few decades, the frequency of pandemics has increased rapidly, yet our efforts to ease their impact have been inadequate on several occasions (Madhav et al., 2018). Recent events have shown that the current method of addressing housing issues is problematic, as the changing or introducing new variables can, in some cases, leads to catastrophic results. COVID-19 has demonstrated that we need to improve of the way we think about planning, design, and research in the field of housing and affordability. Immediately after the COVID-19 crisis began, housing scholars shifted their attention toward measuring the pandemic's direct impacts on housing affordability (Emekci, 2021). Despite the success in highlighting and listing these impacts, it is noteworthy that there is no unified method to measure them, and that current research often focuses on vulnerable groups rather than on inhabitants in general.

1.1 Research questions

This study aims to define the meanings of housing affordability, as well as the major indexes and indicators associated with housing affordability, on both a European-scale, by broadly looking at Germany, United Kingdom and France (the highest populated countries in European Union and the most mentioned in the peer-reviewed papers – according to SJR rating), and on a local-scale, by focusing on the City of Grenoble in France. At the same time, this study investigates the direct and indirect impacts of COVID-19, on housing affordability, while also keeping an eye on how these effects tend to be measured. Consequently, this research works to answer the following questions: What are the indexes of affordability that relates to COVID-19? What are the direct and indirect impacts of COVID-19 on housing affordability? How to measure the impacts of pandemic on housing affordability? What lessons can we learn from COVID-19 to ease the impacts of similar pandemics in the future?

Therefore, this research suggests the hypothesis that, due to the absence of comprehensive and unified methods for measuring the impacts of pandemics on housing affordability that works at a city-wide scale (without focusing on only one class of inhabitants) and that considers the other types of housing affordability indexes, the impact of COVID-19 exceeded expectations and worsened the existing problem of housing affordability. Moreover, this research suggests that recovery from COVID-19 requires a multi-step method that begins by identifying housing affordability indexes, and then investigates and estimates the impacts that COVID-19 had on these indexes – that are major elements of affordability. This will allow us to formulate a comprehensive understanding of the correlation between pandemics and housing affordability, which may lead to easing the impact during this and future pandemics.

Answering the research questions after an investigation of the existing literature, and after an analysis of the study location (the City of Grenoble), has resulted in a theoretical base that lists the effects of pandemics, identifies affordability indexes and how they were affected by COVID-19, and ultimately forms a measurement method that can be used to assess the impacts that pandemics have on housing affordability. The proposed method works by analysing the main indexes that affect housing affordability such as economic aspects (income and expenditures), planning aspects (stock and construction) and social aspects (population need and city components), at the study location. A pre-post comparison, starting with 1 to 2 years before the beginning of the pandemic and one year after it, forms the basis of this analysis

1.2 Plan of the thesis.

This thesis is structured as follows (Figure 1):

- Chapter 1 provides a general introduction of the topic, research questions, the significance of this research, and a detailed investigation of pandemics and housing affordability.
- Chapter 2 explains the method used in this study and develops a framework to measure the impact of pandemics on housing affordability.

- Chapter 3 uses this framework to study a specific study location, the City of Grenoble in France.
- Chapters 4 and 5 list and clarify this research's findings. It also recommends creating a universal housing affordability index and suggests the vital role of using a standard measurement method to evaluate the impact of pandemics on housing affordability.

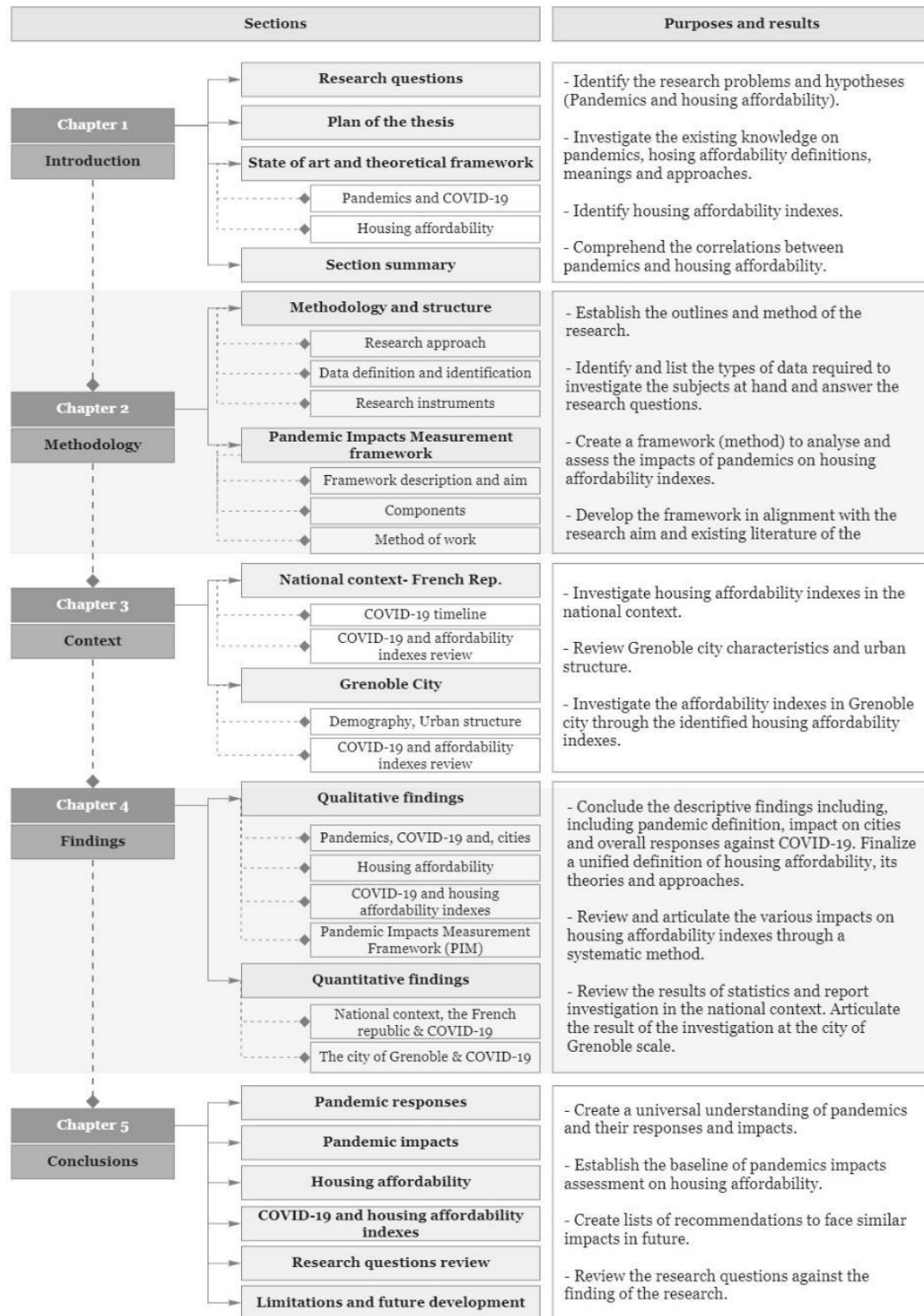


Figure 1. Research outlines and general structure, source: author,2021.

1.3 State of art and theoretical framework

This section is dedicated to investigating the existing knowledge about pandemics, impacts of pandemics, and housing affordability definitions and indexes and highlighting areas that require further research, as well as those areas that are relevant to the subject of this study, ultimately forming its theoretical framework. Its purpose is to bridge the gap formed by the absence of a unified and universal definition of housing affordability among European countries, and to investigate and list the aspects that significantly impact housing and particularly affordability. A parallel purpose of this section is to investigate both the meanings and behaviours of pandemics in urban areas from an urban planning perspective, as well as the methods used to measure the effects that pandemics have on housing affordability.

The investigation methods work on a multi levels approach starting from EU and ending at the City of Grenoble. The investigated topics can be mapped onto two axes. The first axis begins with pandemics and COVID-19 and includes: the general meanings and definitions of pandemics; pandemic behaviour in urban areas; governments' responses to the effects of pandemics; and the methods adopted to measure those effects. The second axis includes: definitions and indexes for housing affordability; the impact of COVID-19 on housing affordability; and the current method used to measure and assess this impact (Figure 2).

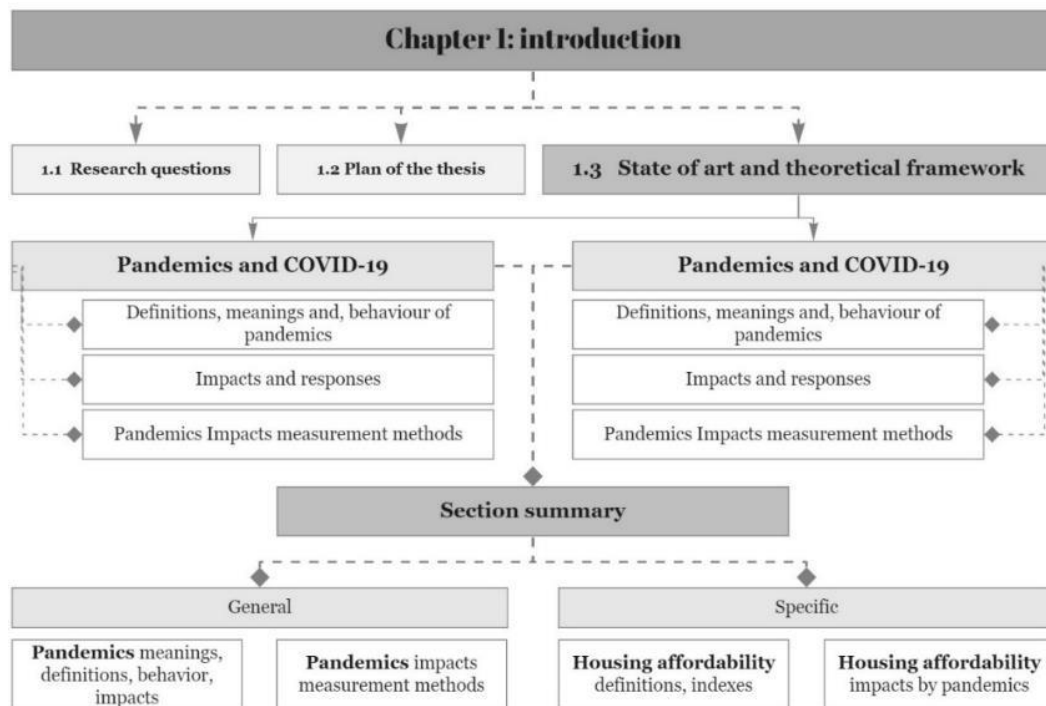


Figure 2. Theoretical framework overall structure, source: author, 2021

1.3.1 Pandemics and COVID-19

This section is divided into three subsections: defining and looking at the meanings of pandemics, concentrating specifically on COVID-19; investigating COVID-19's behaviour of

transmission, its impact on cities, and how governments have responded to it; and finally investigating the method adopted to measure its impact from an urban planning perspective.

1.3.1.1 Definitions, meanings and, behaviour of pandemics

First, it is necessary to distinguish between a pandemic and an epidemic. Etymologically, the word pandemic means an outbreak of a disease that occurs over a wide geographic area, such as multiple countries or continents, and that typically affects a significant proportion of the population (Madhav et al., 2018, Stanborough, 2020). By contrast, an epidemic refers to a disease affecting or tending to affect a disproportionately large number of individuals within a single population, community, or region at the same time (Stanborough, 2020). This led us to classify COVID-19 as a pandemic: it affected an enormous proportion of the world population across the continents (Figure 3), with total recorded cases reaching 10 % of the total world population (Li et al., 2020).

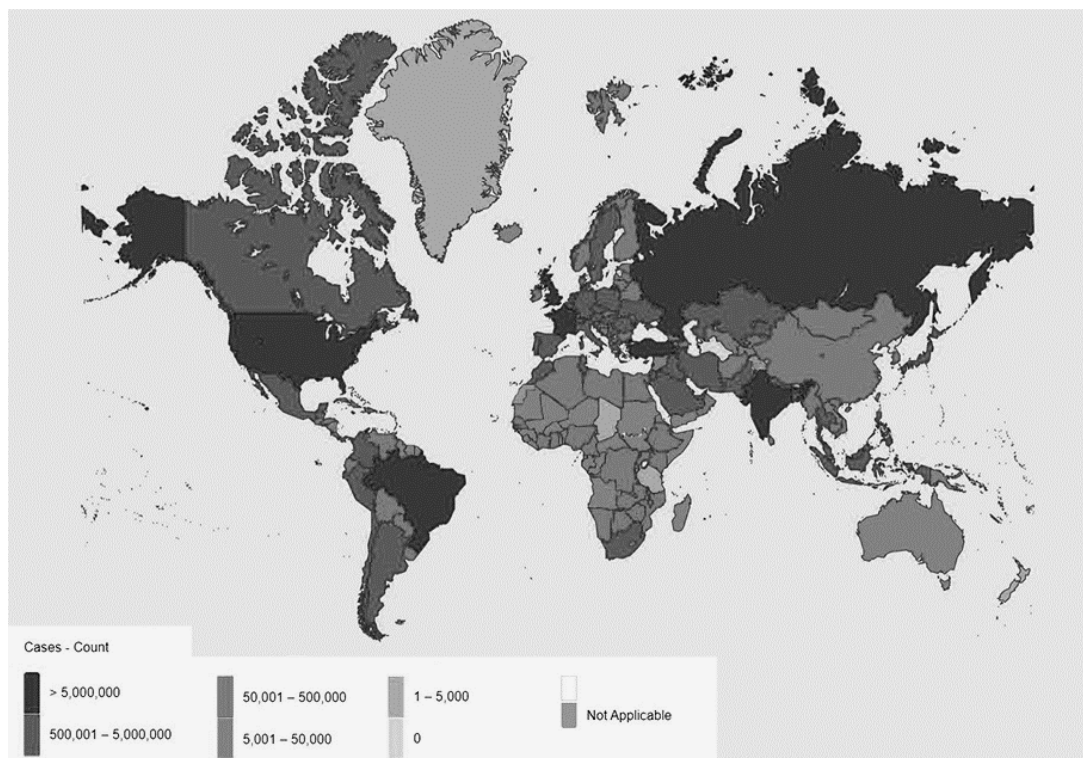


Figure 3. COVID-19 total recorded cases 2020-2021, source: WHO Health Emergency Dashboard, 2021

Meanings

Although this study does not aim to study or analyse COVID-19 from a medical perspective, it is important to understand its meaning by looking briefly at the history of its spread. Virologically, coronaviruses are a large family of viruses, with some causing less severe diseases, such as the common cold, and others causing more severe diseases, such as the Middle East Respiratory Syndrome (MERS) and severe acute respiratory syndrome (SARS) (Li et al., 2020).

On 31 December 2019, the World Health Organization (WHO) was informed by the Chinese authorities that a cluster of pneumonia cases of unknown cause was detected in Wuhan City, Hubei

Province, China (WHO, 2020a). On 30 January 2020, WHO declared this outbreak of a new disease to be a Public Health Emergency of International Concern (WHO, 2020b, Li et al., 2020). Less than two months later, on 11 March 2020, the COVID-19 outbreak was labelled as an international pandemic, and the COVID-19 virus was determined to be highly contagious to humans. As response prevention measures were implemented, many countries went into full isolation, announcing everything to be closed.

Behaviour of COVID-19

The patterns of disease transmission have always paralleled wars, people's travel, and migration routes. Accelerated urbanization, moreover, has also exacerbated the emergence of infectious diseases (Frenk et al., 2011). However, the source of the COVID-19 has yet to be determined. A zoonotic source to the outbreak has not been identified, but investigations are ongoing (WHO, 2020a, Phe, 2020). SARS-CoV-2 or COVID-19 is primarily transmitted between people through respiratory (droplet and aerosol) and contact routes. Transmission risk is highest where people are in proximity (within 2 metres as identified by WHO). Airborne transmission can occur in health and care settings where procedures or support treatments that generate aerosols are performed. Airborne transmission may also occur in poorly ventilated indoor spaces, particularly if individuals are in the same room together for an extended period (Phe, 2020). Currently, human-to-human transmission is occurring extensively. Consequently, precautions to prevent human-to-human transmission have been deemed appropriate for both suspected and confirmed cases (Phe, 2020).

Procedures, instructions, dedicated authorities, and institutions to deal with COVID-19 were established and enacted in many cities. These actions encompassed a plethora of spatial, functional, and societal measures. The promotion of public health and disease prevention at the communal level also became more widespread (Geltner, 2019). Since the outbreak of COVID-19, the great challenges have been responding to it and determining how to measure and collect data related to it.

Many agencies, such as the European Centre for Disease Prevention and Control (ECDC), have engaged in a worldwide collaborative effort to create a systematic procedure to address these challenges (Figure 4). This has allowed for two-level measures to be established. The first level refers to international measures that are adopted worldwide, while the second level refers to those measures developed and adopted at the national or regional level.

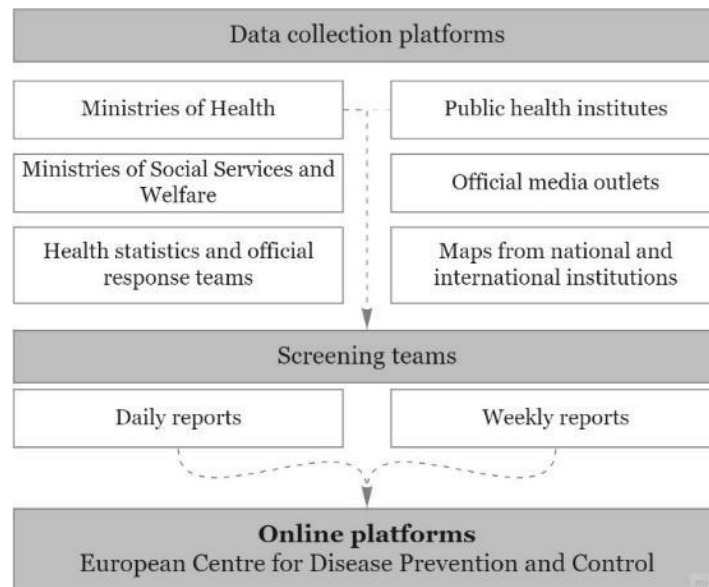


Figure 4. ECDC method of data collection and sharing, source: ECDC, author edit, 2021

1.3.1.2 COVID-19 impacts and responses

Pandemics have affected humanity throughout the course of history. They have greatly influenced societal relations, health systems, city development, and politics (Huremović, 2019, Leach et al., 2021). Since its emergence late in 2019, the coronavirus pandemic has triggered what is considered to be the worst public health crisis in a century, with outbreaks spreading to virtually every corner of the globe: first, between interconnected metropolises, and then through the urban-rural continuum. Cities, as entry points for COVID-19, are a critical line of defence against the further spread of the pandemic (Leach et al., 2021).

Different urban forms and planning factors can influence how COVID-19 will impact cities and their inhabitants' lives. Although most of the investigated literature has focused on economic factors such as job losses, market degradation and the decline of the value of trade, other factors are just as vital (Adam Tinson and Clair, 2020).

Identifying and listing all the effects of COVID-19 is complicated since they include many secondary ones; hence, this research has classified the effects into three main categories that result directly from COVID-19. A comprehensive table for the secondary impacts has been constructed as well (Table 1).

Economic impacts: While there is no way to tell exactly what the economic damage from the global COVID-19 coronavirus pandemic will be, there is widespread agreement among economists that it will have severe negative effects on the global economy (Szmigiera, 2021, McKibbin and Fernando, 2020). Early estimates predicted that, should the outbreak become a global pandemic, most major economies would lose at least 2.9 per cent of their gross domestic product (GDP) over 2020. This forecast was then adjusted to an estimated GDP loss of 4.5 per cent (Figure 5) (Szmigiera, 2021, McKibbin and Fernando, 2020, Segal and Gerstel, 2020). In addition, the threat includes not only direct

losses but also a global economic recession, a rapid increase of unemployment rates, and the increase poverty worldwide. These potential effects, moreover, will require significant time to be dealt with and treated properly (Szmigiera, 2021).

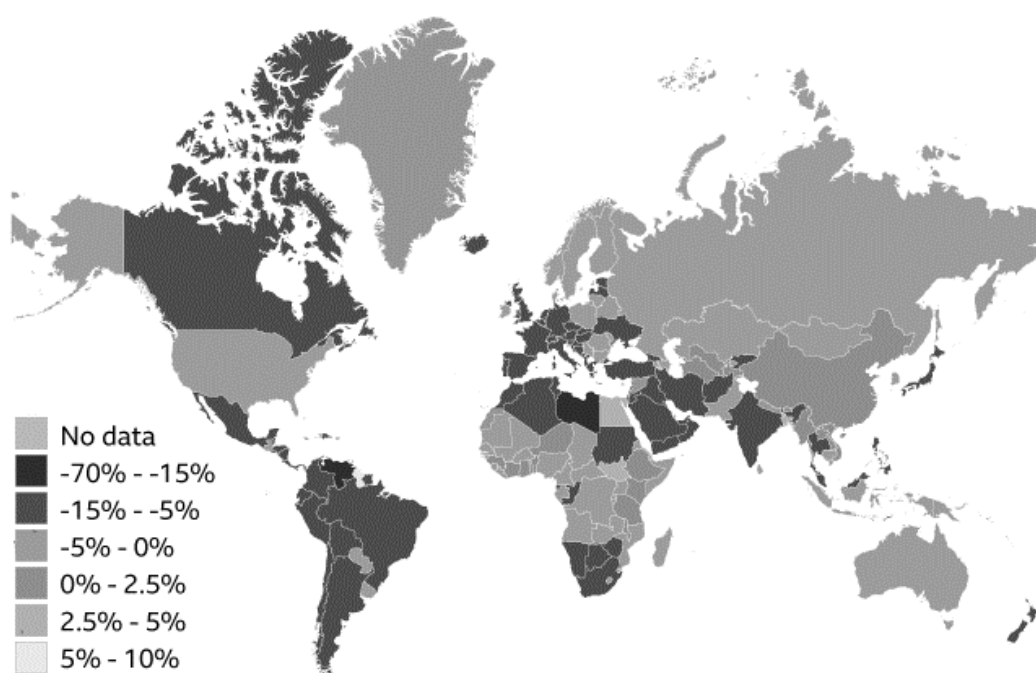


Figure 5. Global recession indicators, source: International Monetary Fund, 2020

Social and psychological impacts: to face the spread of COVID-19, cities were forced to adopt full lockdown measures, which in turn resulted in full isolation of people in their homes (Allain-Dupré et al., 2020). The negative effects of this isolation measure started to appear shortly after the lockdown started through the increasing number of reported domestic violence incidents and cases of depression, and the reduction of productivity (Cullen et al., 2020). Although COVID-19 has led to an increased awareness of physical health, mental and social health did not receive the same amount of attention (UN, 2020). If not properly addressed by official policy, the social crisis created by the COVID-19 may also increase inequality, exclusion, discrimination, and global unemployment in the medium and long term. Comprehensive, universal social protection systems, when in place, play an important role in protecting workers and reducing the prevalence of poverty, since they act as automatic stabilizers. In other words, they provide basic income security at all times, thereby enhancing people's capacity to manage and overcome shocks (Allain-Dupré et al., 2020).

Environmental impacts: Scientists have confirmed that air quality in certain regions has improved since the first global lockdown. The slowing down and stopping of industries and transportation, such as aviation, has led to a reduction in air pollution in countries severely affected by the virus, including China, Italy, and Spain (Cheval et al., 2020, Qiu et al., 2020). In the long term, the COVID-19 pandemic may offer lessons and opportunities that lead to positive environmental action.

For instance, we will have a new baseline of what can be achieved digitally, such as remote work, education, shopping, and more (Cheval et al., 2020). This is not a question of whether the virus is “good” or “bad” for the climate, but rather if we can create a functional economic system that supports people without threatening the life of Earth (Cheval et al., 2020, Saadat et al., 2020).

Table 1. The impacts of COVID-19, source: as indicated in description column.

Category	Subcategory	Description
Economic	Business closures – retail market	Due to the lockdown and physical distancing of all nonessential business - 195 million full-time jobs were lost (Pak et al., 2020).
	Job losses and labour market	All sectors of employments, and especially in the sectors that requires physical attendance. Up to 30% reduction (Wood and Sweney, 2020)
	Decline in global trade	Drop in oil price, global lockdown, and global stock market fell. 4% decrease in value (Pak et al., 2020)
	Increase global debts	Decline in trade leads to decline in national income and therefore decline in debt payments(Pak et al., 2020).
	High cost of healthcare	Mobilizing healthcare infrastructure at its full capacity requires more working force and higher operational costs.
	Tourism and travel	Forms one of the important income sources for many countries. The sector of tourism was fully closed due to quarantine restrictions and boarder closure causing a reduction of 85% of tourism income (Tounta, 2020).
	Manufacturing	Where physical distancing required led to reduce the capacity of production and full shutdown in many industries (Pak et al., 2020).
	Agriculture and food security	Restricted access to lands or markets and the shock in trade chains (Yu et al., 2021, FAO, 2020).
Social and psychological	Increase poverty	Many people depend on daily and temporary income; closure led to severe income reduction and increased poverty indications (Pak et al., 2020).
	Physical health.	Depriving people form outside activity such sport and engagements, has led to dangerous indicator of the degradation of physical health (Cullen et al., 2020)

	Depression, anxiety and mental health.	People have dealt with the lockdown with different responses, however extending the isolation period has led to severe depression and anxiety in many cases (Cullen et al., 2020).
	Elderly care	Elderly people have faced barriers to obtaining accurate information, food, medication, and other essential supplies during quarantine conditions (Chakraborty, 2020).
	Violence	As an extended result of isolation, anxiety and bad living conditions domestic violence reported cases have increased 32% (Humphreys et al., 2020)
	Inequality	living in crowded housing and work in the low skill jobs, such as supermarkets and elder care, which are deemed essential during the crisis have increased COVID-19 cases among low-income individuals (Bhanot et al., 2020).
	Exclusion and discrimination	COVID-19 has widened the gap between societies and led to increased untargeted discrimination for low income and vulnerable groups (Bhanot et al., 2020).
	Religious practice	The cancellation of the worship services of various faiths, as well as the cancellation of pilgrimages surrounding observances and festivals (Bhanot et al., 2020).
Education	Unequal access to learning technology	Lack of access to technology or good internet connectivity is an obstacle to continued learning, especially for students from disadvantaged families (UNESCO, 2021).
	Unequal access to educational resources	Lack of limitations and exceptions to copyright can also have an impact on the ability of students to access the textbooks and materials they need to study (UNESCO, 2021).

	Academic integrity	The lack of student-to-teacher interaction has also led students to feel less passionate about the integrity of their work (Eaton, 2020)
	Hazard controls	Daily short-term closure to clean or disinfect if an infected person has been in a school building regardless of community spread (Melnick and Darling-Hammond, 2020).
	States of emergency	Banning mass protests, postponing elections or holding them while the opposition cannot effectively campaign, selectively enforcing lockdown rules on political opponents (Stasavage, 2020).
	Human rights & freedoms	The emergency powers enacted by governments in order to stem the spread of the pandemic have inadvertently led to more pressures on human rights and civil liberties (Stasavage, 2020).
Political impacts	Democracy	National governments found themselves with no other choice but to suspend, cancel, or postpone numerous democratic elections at both national and subnational governmental levels (Stasavage, 2020).
Environment	Emissions and air quality	The rapid decrease in greenhouse gas (GHG) due to the closure of many industries and travel pan has led to increase air quality (Venter et al., 2020).
	Forestry	Isolation procedures, reduction in CO2 and quarantine has led to increase greenery caps and forest reclaimed its original inhabitant (BBC, 2020).
	Resources	Reduction in heavy industry and manufacturing led to enhance and reduce the use of natural resources such as oil and water (BBC, 2020).
	Perception	The general perception of what can be achieved has changed, policies are better able to improve the environment (BBC, 2020).

Responses against COVID-19

An examination of the responses to the first wave COVID-19, reveals that these responses, as well as the policies that were adopted, were often temporary, place-blind, and isolated. They were primarily focused on increasing awareness of the virus and changing the behaviour of people in an effort to reduce direct contact and therefore to reduce the spread of COVID-19 (Development, 2020).

These measures were promoted by the World Health Organization (WHO) by (1) reducing contact possibility by creating separated circulation methods inside and around gathering spaces and services buildings, (2) mandating the use of protection sets such as face masks, (3) increasing awareness about self-hygiene and promoting the use of hygiene products on a daily basis and, (4) banning any type of gathering in any place (OECD, 2020, Li et al., 2020).

However, at the urban level, and not long after the first wave of the pandemic, many reports and studies were published stressing the need to rethink the urban form and to adopt new measures. Most of the studies focused on the followings aspects (UN, 2020, Sharifi and Khavarian-Garmsir, 2020):

- ***Transportation autonomy***: city transportation should be planned in a way that allows people without cars to walk, bike, or otherwise move safely. Bike-friendly methods are already in place around the globe, specifically in those cities where the already-existing infrastructure facilitated this shift.
- ***A mixture of green and blue spaces***: public demand for urban parks has been high during this pandemic. Cities should include new green and blue areas such as pocket parks, watersheds, and the likes in the heart of urban areas.
- ***Decentralization of core services***: ease of access to every city's core services should be prioritized moving forward. Establishing an equality and equity in services disruption is part of the next era of urban planning.
- ***Digitalization and data management***: easy access to data was important in dealing with the pandemic. Granular, local data should be available digitally to aid in faster decision-making, local mapping, and community information

However, from a wider lens, UN-Habitat's *World Cities Report 2020: The Value of Sustainable Urbanization* demonstrated that cities generate greater economic value when they are optimally shaped and function well. It also emphasized that a city's resilience and ability to innovate allows it to adapt by incorporating new shapes and functions (Habitat, 2020). Yet for cities to realize these opportunities, authorities at all levels need to be granted adequate powers and resources to formulate integrated, locally appropriate policies that could transform the current crisis into an opportunity for future development.

As such, the UN-Habitat has formed a guideline for future development that stresses the need to rethink urban strategies to successfully face pandemics. The table below list these strategies and methods (Table 2).

Table 2. Guidelines for enhanced responses against pandemics, source: UN-Habitat's, 2020.

Strategy	Method of adaption.
Cities form and function	How urban morphologies and systems can be reconfigured at different scales to not only enhance their resilience to the effects of the pandemic but also make them more sustainable and productive in the long term through inclusive planning.
Poverty and inequality	Designing targeted interventions that mitigate the disproportionate impacts of COVID-19 and related restrictions on poor and vulnerable groups through emergency assistance and service provision, while also taking steps to address the underlying causes of their exclusion.
New urban economy	Developing a suite of tailored economic support and relief packages to help smaller businesses, informal workers and at-risk sectors to survive the crisis, with an emphasis on “building back better” by promoting the transition to a greener, more equitable urban economies
Urban legislation and governance arrangements	Recognizing the need for more integrated, cooperative multi-level governance between national, regional and municipal governments, with an emphasis on developing more flexible and innovative institutional and financial frameworks for cities to respond effectively to the unfolding crisis

1.3.1.3 Pandemics impacts measurement methods.

Measuring the impact of a pandemic can be a difficult and expensive process (Ejiogu et al., 2020). It requires deciding which outputs (activities) should be measured, how to measure them, which tools to use, how to analyse the data, how to interpret it correctly, and deciding how and with whom the data should be shared. Moreover, social effects can be difficult to measure; human behaviours can be complicated to predict and to objectively assess (Kachanoff et al., 2021). Therefore, before discussing the methods that are currently used to measure the effects of COVID-19, this research comprehensively explores the meaning of impacts and the ways in which impacts are measured, laying the necessary groundwork for comprehending the subjects addressed in the following chapters.

After a thorough literature review, this research has identified several definitions that suggest different methods and approaches for measuring the impact of an action or index. The purpose of investigating these definitions is to shape the meaning impact and how it affects the subject. This understanding is vital to form the proposed framework for measuring the impacts of pandemics¹

¹ Appendix A provides a list of other definitions explored.

According to the United Nations glossary, defining impacts implies changes in people's lives. This might include changes in knowledge, skill, behaviour, health or living conditions for children, adults, families, or communities. Such changes are positive or negative long-term effects on identifiable population groups produced by a development intervention, directly or indirectly, intended, or unintended. These effects can be economic, socio-cultural, institutional, environmental, technological or of other types. Positive impacts should have some relationship to the Millennium Development Goals (MDGs), internationally-agreed development goals, national development goals (as well as human rights as enshrined in constitutions), and national commitments to international conventions and treaties." (Bester, 2012).

The European Commission sees the impacts from a holistic view as the definition consider the assessment method. "In an impact assessment process, the term impact describes all the changes which are expected to happen due to the implementation and application of a given policy option/intervention. Such impacts may occur over different timescales, affect different actors and be relevant at different scales (local, regional, national and EU). In an evaluation context, impact refers to the changes associated with a particular intervention that occur over the longer term." (EU, 2018).

Another definition by Development Co-operation Directorate (OECD-DAC) considers the inputs and outputs as vital variable in the process of measuring and impact. "The outputs (actions – either isolated or part of a program) have a core set of goals meant to be fulfilled that end up encompassing multiple side effects." (Simon Hearn and Buffardi, 2016).

Impact measurement refers to the process of quantitatively and qualitatively evaluating the impact on an organization (Y.M, 2021). However, defining "measurement" is tricky since the term has several meanings and implications. The simplest definition is "the processes and acts taken to represent the values of something; it includes tangible parameters such as length, width, weight, value...which must be true and non-negotiable, and, it also includes intangible parameters such as performance, ability, [and] effectiveness...and those parameters are usually subjected to judgment and test" (Y.M, 2021).

After broadly defining the term "impact," this study raises the questions: how does one measure the impact of something? And more importantly, what indexes should be used to measure accurately? Therefore, it is important to explore and categorize the current methods used to measure impacts. There are several different methods, each of which depends on and relates to a specific field of study. Table 3 identifies these different methods and the instruments used for each one. This paves the way for the next section, which discusses these identified methods of measurement.

Table 3. *Impact Measurements Approaches*, source: Gertler et al., 2011.

Approach	Purpose	Instruments
Counterfactual Analysis	“Measuring an impact by making a comparison between what would have happened differently in the absence of a certain output and estimating a cause-effect relationship. Ultimately, this way of looking at an impact sees it as the extent to which an action has a particular effect. Note that due to the complexity of certain outcomes, distinguishing the output that led them is not always intuitive”.	Qualitative and quantitative Instruments
Chain Perspective Analysis	“Impact measurement is seen from the perspective of outputs (the direct effects of an action or intervention) and outcomes (short and mid-term changes). This view usually allows for a visual map with multiple chains – a characteristic of the theory of change methodology. Moreover, different spheres of influence can also be identified, from the sphere of control to direct and indirect influence. Impact fits in the sphere of indirect influence, which means that it falls beyond any specific development program.”	Qualitative and quantitative instruments
Borderless Analysis	Positive and negative, primary and secondary long-term effects produced by a development intervention, directly or indirectly, intended or unintended.	Qualitative and quantitative instruments
Colloquial perspective analysis	Fact-based and not accurately measured judgments of an impact.	Qualitative instruments

Measurement process

Like any other scientific process, measuring an impact requires systematic, clear, and objective steps that determine and clarify the method and objectives underpinning the measurement (Figure 6). The following steps should be taken to measure an impact (Gertler et al., 2011, Khandker et al., 2009):

- Identify the subject and objectives of the measurement. For example, one might decide to measure financial losses in the trade market, or the reduction in quality of construction in specific city as a result of a new variable – COVID-19, in this case.
- Clearly establish the intention of the measurement, such as wanting to estimate losses to avoid similar outcomes, or to enhance the current ways in which certain variables are managed.
- Identify the intended outcomes, whether as numeric or descriptive bases.
- Investigate and identify the indicators, whether direct or indirect, that are linked to the subject of measurement, and are considered to align with the objective of the measurements.
- Based on the availability of data and suitability of instruments, select the appropriate method

from those mentioned in Table 3. Measuring could require more than one approach.

- Finally, analyse the data and organize it in the form of outcomes. ultimately feeding back into the subject and objectives of the measurement.

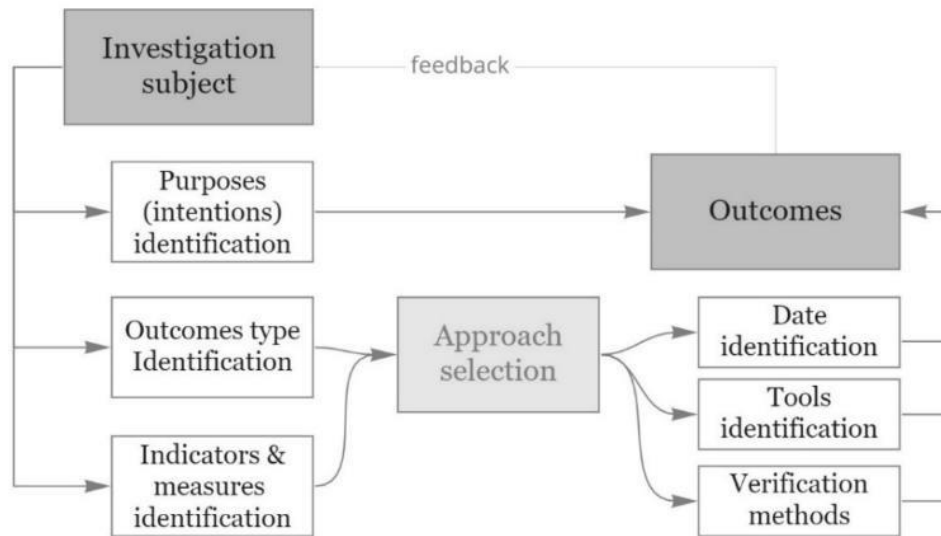


Figure 6. Overall Process of Impacts Measurement, source: author, 2021.

Indicators, variable, or indexes.

An indicator is used to measure a concept and is typically used in quantitative research (Gertler et al., 2016). In addition, it is important to distinguish between an indicator and an index. indexes refer to things that can be relatively unambiguously counted, such as personal income, household income, age, number of children, or number of years spent at school. indexes, in other words, are quantities (Jones, 2020). However, social scientists also use indicators to measure less directly quantifiable concepts such as job satisfaction. These require identifying indicators that stand for concepts like “job satisfaction” and others like it. Such indicators allow concepts to be treated quantitatively like any other measure (Thompson, 2017). Meanwhile, from a mathematical research a variable means: a quantity that can have any one of a set of values or a symbol that represents such a quantity. In research a variable simply refers to a person, place, thing, or phenomenon that researcher trying to measure in some specific methods and ways (USC, 2020).

The success or failure of measurement is directly linked to the clear identification of indicators, indexes, and variables. These play an important role in collecting data and establishing what framework and measurement should be used (Thompson, 2017). indexes are closely related to the concept being measured. For example, questions about how much a given person earns are direct indicators of personal income, but the same question would only be an indirect measurement of the concept of social class.

Since identifying indicators and indexes can be complicated and requires a deep understanding of the subject being measured, several studies have suggested theoretical guidelines to ensure a successful selection. Table 4 lists these guidelines.

Table 4. Indicators and indexes selection guidelines, source: UN, 2010.

Characteristics	Guideline
Valid	Accurate measurement of a behaviour, practice, or task that is the expected output or outcome of the intervention.
Reliable	Measurements that are consistent over time and to different observers.
Precise	Operationally defined in clear terms.
Measurable	Quantifiable using available tools and methods, but also having a balanced combination of quantitative and qualitative data.
Timely	Provides a measurement at time-intervals relevant and appropriate to the goals of the programme.
Programmatically important	Linked to the programme in some way, whether to solve a problem or to achieve the objectives of the programme.
Alternatives	When quantitative indicators cannot be identified, qualitative methods offer a valuable alternative. When it is difficult or not possible to measure “benefits” or “impact” in simple, quantitative terms, it is almost always possible to gather qualitative data. In many cases, qualitative indicators provide more relevant information about the success, effectiveness, or impact of the intervention (Bott, Guedes and Claramunt, 2004).

Indicator types and use

It is important to note the differences between indicator types. Different types are used to develop a suitable and appropriate approach for carrying out the study or investigation. This research has identified five main types of indicators (Figure 7). (1) Process Indicators are used to monitor the number and types of activities carried out. (2) Results Indicators are used to evaluate whether the activity achieved the intended objectives or results. Results indicators can be developed at the output, outcome, and at the impact levels (UN, 2010). (3) Output indicators illustrate the change related directly to the activities undertaken within the investigated subject, such as how many people are trained to be leaders. (4) Outcome indicators relate to change that is demonstrated because of the interventions in the medium-to-longer term. (5) Impact indicators measure the long-term effects of interventions or new variables.

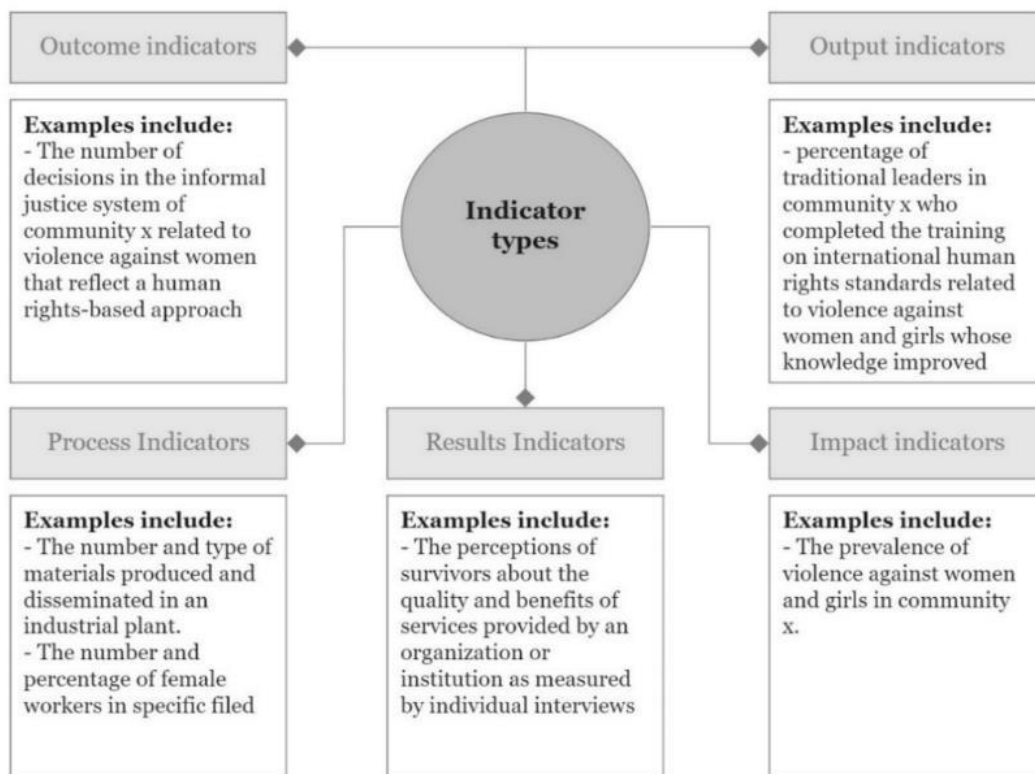


Figure 7. Indicator Types with Examples, source: UN,2010.

1.3.2 Housing affordability

Like the previous section, this section is divided into three subsections. The first establishes a foundational definition of housing affordability and identifies its indicators and measures. The next section looks at COVID-19's impact on housing affordability, and the final section describes the methods used in previous research to identify the impact of pandemics.

1.3.2.1 Definitions and, synonymous.

The cost of housing and shelter – both for renters and owners– in relation to a certain individual's or household's disposable income is referred to as housing affordability (Kallergis et al., 2018, Mulliner and Maliene, 2011). Although there is no universal definition for this term, its meaning is generally understood. At the same time, identifying the proper geographic scope for housing markets, as well as adequate definitions of representative reference persons and households, and their changing situations over time, can be difficult in practice (Mulliner and Maliene, 2011). In its most basic form, housing affordability simply refers to the rent-to-income ratio or house-price-to-income ratio; more sophisticated housing affordability measures consider (1) how much non-housing expenditures are limited by how much is left after paying for housing, or (2) they distinguish between "purchase affordability" and "income affordability" (Stone, 2006).

Synonymous and associated terminologies.

Establishing a universal definition of housing affordability difficult. As a first step toward a definition, a comprehensive list of synonyms for “housing affordability” used in several European countries (Germany, United Kingdom and, France) has been compiled, the purpose is to create an accurate investigation boarder to form the understanding of housing affordability components, indicators and indexes¹

According to Rosenfeld, 2017, in Germany, housing affordability is always associated with several terms; after a proper translation through the context of meaning, terminologies that appear are social housing, municipal housing, social rented housing, rental price brakes, housing benefit², society for building and living³ (Rosenfeld, 2017). Meanwhile, in the United Kingdom, affordability of housing is usually seen through the eyes of social subsidies, where housing affordability is meant to include social rented, affordable rented and intermediate housing, and social assisted housing (Preece et al., 2020). French understanding of housing affordability is the most concentrated one on social housing, where most of the time affordability is sees as social housing, low-income housing⁴, and public (state) housing, subsidized housing, co-operatives housing.

¹ **Appendix B** provides comprehensive listing of other terminologies for other countries as well.

² Wohngeld - translated to housing benefit.

³ Gesellschaft für Bauen und Wohnen – translated to society for building and living.

⁴ Habitation à Loyer Modéré (HLM) – translated to low-income housing.

The investigation of various terminologies suggests that housing affordability is most often referred to as “social housing,” or the type of housing that is controlled or managed by an official authority to make it possible for specific type of population, namely those belonging to the “low-income” population, to access housing. But this more accurately describes “affordable housing,” or government-subsidized housing for people with special needs (financially and socially) (Li, 2015). This should be distinguished from “housing affordability,” which refers to the general level of housing prices relative to the general level of household or family incomes, usually measured by dividing median home prices by median family incomes.

At the same time, it’s vital to distinguish between housing affordability as it means the general level of housing prices relative to the general level of household or family incomes, often measured by dividing median home prices by median family incomes, meanwhile, affordable housing is government-subsidized housing for people with pre-defined criteria such as income, social status, needs, ... etc, (Li, 2015, Kallergis et al., 2018).

Definitions

Many scholars have agreed that defining housing affordability is conditional and that establishing a universal definition is an impossible task (Stephen Ezennia and Hoskara, 2019). Definitions and indexes involved in housing affordability vary depending on the context. This study has gathered the most common definitions of housing affordability (reflected in affordable housing) used by official authorities, concerned agencies, and housing providers across Europe.

The purpose of investigating the definitions is to comprehend the meanings and indexes of housing affordability, like the investigated associated terminologies; definition varies between Germany, the United Kingdom, and France¹. Although these definitions don't rank to an authoritative² or legislative level, yet it provides a general understanding of the topic.

- *Germany*: “Affordability means the regulation and laws adopted in all federal states, with respect to the uniqueness and singularity of each state. It aims to support those households which would otherwise not be able to find appropriate accommodation on the housing market. These include low-income households and families and other households with children, lone parents, pregnant women, the elderly, the disabled, the homeless, or others in need” (Droste and Knorr-Siedow, 2014).
- *United Kingdom*: “Affordable housing includes social rented housing, affordable rented housing, and intermediate housing, provided to specified eligible households whose needs are not met by the market. It can be a new-build property or a private sector property that has been purchased for use as an affordable home” (Preece et al., 2020, MHCLG, 2019).
- *France*: “Affordable housing is the term given to accommodations which are provided at

¹ **Appendix C** provides a comprehensive listing of other definitions across other European countries.

² Authoritative: a definition clearly identified and used by the authority of the countries under investigation

affordable rates (calculated based on total income of household), on a secure basis to people with low incomes or with needs (elderly, employee, vulnerable people, etc.). Social housing properties are usually owned by the state, in the form of councils, or by non-profit organisations such as HLM, OPH, ESH, or EPL.¹” (IBHS, 2018b, Scanlon and Whitehead, 2011)

1.3.2.2 Affordability approaches and indexes.

There has been a long-running but not wholly resolved debate about different approaches to measuring affordability and what standards or norms should be used. Some argue for using “affordability ratios” (housing cost to income) while others argue for using “residual income” (income left after housing costs, relative to a poverty standard for non-housing consumption (Bramley, 2012, Hulchanski, 1995, Stone, 2006, Meen, 2018).

While normative affordability ratios are supported by common sense, consumer demand theory, and many practical rent subsidy systems, relying on residual income reflects the traditional definitions and measurements of poverty as well as the use of “equivalisation scales” to reflect household size and composition (Wetzstein, 2017). This unresolved theoretical debate is compounded by a surprising lack of consensus over time, and in different countries and sectors, about what the right normative standards are for either ratio.

To properly examine approaches to affordability, a sample of literature and policy reports from various European countries have been examined although attention was directed mainly toward four major approaches, which are treated below (Figure 8). It is important to reiterate, however, that there are more than four approaches that are used to measure and discuss affordability.

House price to income approach.

House price-to-income ratios are calculated by dividing property prices by annual earnings. The house price-to-income ratio is an indicator of affordability in an area and can be used to compare affordability in different time periods and different regions more accurately than just comparing the property prices (Md, 2015, Meen, 2018).

Formula [Affordability ratio = rent / income].

Housing expenditure to income approach.

An alternative to the house price-to-income ratio is the housing expenditure-to-income ratio. This measure better reflects the affordability changes across time because it includes the changes in interest rates (Hulchanski, 1995, Meen, 2018).

Formula [Consumers’ expenditure (excl. housing) + housing costs + saving from current income = post-tax household earned income + post-tax income from net financial assets]

Residual income approach.

This approach is based on housing and non-housing consumption standards. The method is to

¹ OPH : Offices Publiques de l’Habitat, ESH : Entreprises Sociales pour l’Habitat, EPL : Entreprises Publiques Locale

subtract from disposable income the monetary value of a pre-defined standard of non-housing needs; this, therefore, determines how much is affordable for housing (Stone, 2006, Meen, 2018).

Housing supply measure approach.

Instead of concentrating on housing demand and costs, this approach suggests that the supply of homes should be calculated and provided based on the availability of homes to the lowest income groups. This could solve the gap of the imbalance between demand and supply (Meen, 2018).

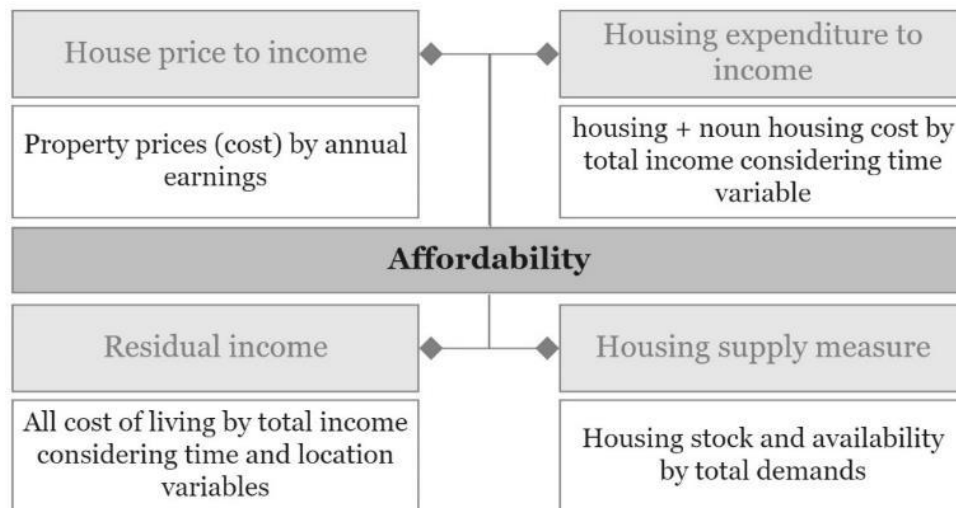


Figure 8. Affordability approaches, source: Meen,2018.

Other approaches

Aside from these four major approaches, a recent study by Hoskara and Ezennia (2019) has examined the question of affordability from other perspectives. It classifies the approaches into three main themes, beginning with conventional methods such as residual income, income ratio, and composite method. It then turns to scarcely used methods including the “behavioural approach” and the “subjective approach,” before finally investigating and listing other newer methods such as multi-criteria methods, the Gini coefficient, and mobility probability plot (Stephen Ezennia and Hoskara, 2019) (Figure 9).

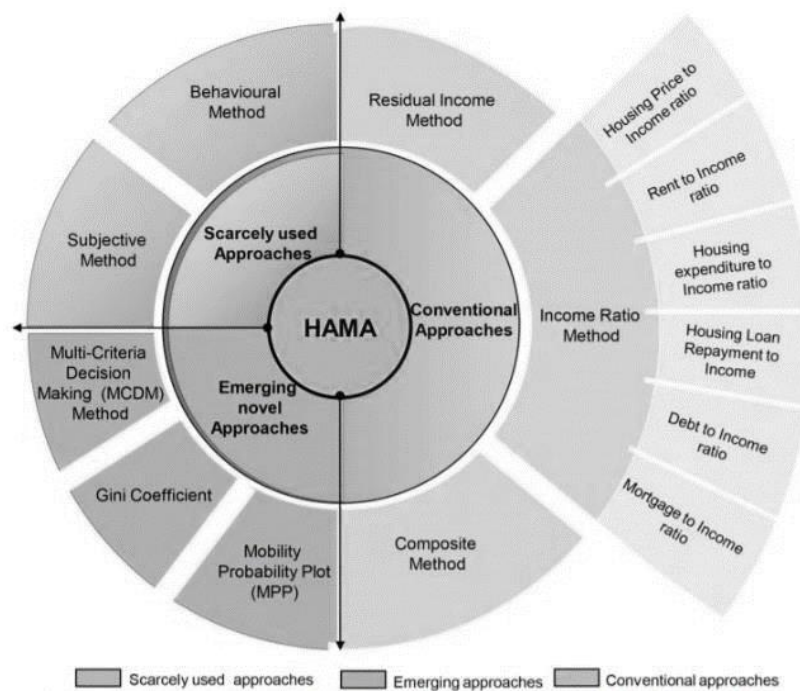


Figure 9. Housing affordability measurement approaches (HAMA), source: Stephen Ezennia, et H., 2019.

Affordability indexes

Researchers, authorities, and concerned agencies often use the term “affordability index ” and sometimes “affordability indicator” as a measure of an average person’s ability to purchase a particular item, such as a house in a particular region, or ability to afford the general cost of living in the region. This type of index typically compares the price of a good or the general cost of living in a region to that of other regions or to some measure of personal income. The resulting number may be presented as a raw ratio or normalized according to a given index number. Affordability indexes can give an idea of the standard of living or a given region or area’s attractiveness to movers (Meen, 2018).

An investigation of these indexes allows us to formulate a broad definition of housing affordability indexes that have been adopted in most European countries, despite the outward differences in their definitions or in the terminologies they used, as reviewed in the previous sections. To this extent, Table 5 was prepared to list the indexes as direct and indirect to facilitate the investigation of the impacts on the following sections.

Table 5. Housing affordability indexes, sources: Meen, 2018, Bramley, 2012, Kallergis et al., 2018, Li, 2015, Ciora, 2015.

Indexes		Description
Direct	Indirect	
Household income	Fixed income per household per month or per year.	The total amount of income earned from all sources (jobs, home trade, small business, government aid, etc).
	Other income per household.	
Household expenditure (cost of living without rent)	Total fixed expenditure per household per month or per year.	The total amount of resources spent on food, education, health, leisure, etc., by all household occupants.
	Temporary expenditure per household.	
Housing expenditure	Cost of rent per month and per year;	The total amount spent by the household on rent, mortgage, and utility bills (water, electricity, municipal services, etc.).
	cost of utilities and services per month or per year.	
Housing provisions	Total available units; existing housing units;	The total available, planned, and required housing stock
	total planned or under-construction housing units; and number of units required by applicants.	
Whom and where variable	Type of population targeted (low-income, middle-income).	The aim is to expand the affordability base to include all those in need and not only the vulnerable groups in each city.
	Geographical location and city capacity.	

1.3.2.2 COVID-19 impacts on housing affordability.

Although the impacts of COVID-19 were observable on many levels, only some of these were clear and easy to pinpoint, such as COVID-19's effect on health and the economy. Other effects did not surface immediately, like those on mental health and wellbeing, but perhaps had deeper impact on cities and society more generally (Kang et al., 2020). The responses to these effects, as well as the methods to assess these effects, varied according to location and each authority's priorities (Kang et al., 2020). These impacts can broadly be categorized into direct and indirect impacts, as explained below (Figure 10).

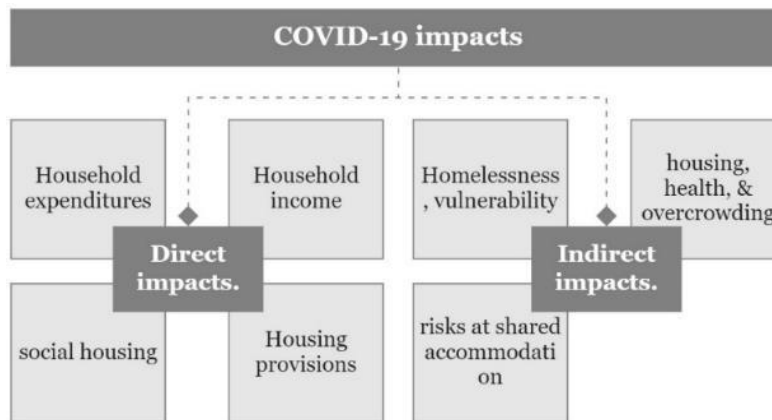


Figure 10. COVID19 impacts on housing affordability indexes, source: author interpretation from Doerr and Gambacorta, 2020, Hilditch, 2020, Kachanoff et al., 2021.

Direct impacts.

From housing conditions to overcrowding and homelessness, COVID-19 has affected all sectors related to housing the effects were amplified and surfaced through the followings.

(1) *Household income*: Preliminary indicators on job destruction and claims for unemployment benefits across European Union (EU) countries suggest that the impact of the COVID-19 pandemic on households will likely be exceptionally high (OECD, 2020). Early findings suggest that the risk of job loss is highest in southern Europe and France (Doerr and Gambacorta, 2020). The total employment income in the EU decreased by 4.8% in 2020, with the largest decreases being due to absences and reduced hours. Wage compensation schemes mitigated the income loss to about 2% in the EU in 2020 (Brewer and Gardiner, 2020, Eurostat, 2021).

(2) *Household expenditures (renters and landlords)*: The adoption of lockdown procedures was necessary to face the spread of COVID-19. This has resulted in an increase in total consumption per household. Although household saving rate in the EU decreased during the third quarter of 2020, it was still 4.5 percentage points (pp) higher than it was the year before. The main reason for the year-to-year increase is that household final consumption expenditure was still 3.6% lower in the EU than it was one year earlier. Household gross disposable income recovered and was 1.5% higher during the third quarter of 2020 compared to the third quarter of 2019 (Eurostat, 2021)

(3) *Housing provisions (construction and planned programs)*: COVID-19 is affecting the global construction industry as projects now face (a) supply chain issues, (b) transportation problems, (c) labour shortages, and (d) financial difficulties. Estimating the total losses in construction is difficult because it encompasses several aspects including the type of projects, construction timelines, and financial types. However, initial estimates show a 65% decrease in all construction projects. It is worth keeping in mind that construction constitutes between 4 and 8% of the total GDP in several EU countries, and the largest decline in GDP has reached 5.6% (Eurostat, 2021).

(4) *Impacts on social housing*: As of the date of this study's completion, there are no studies

that accurately list the exact effects of COVID-19 on social housing sectors; however, several governmental reports and studies, such as Housing Europe's annual report and Eurostat's financial report, suggest that the housing sector may face long-term challenges as a result of COVID-19 and the responses to it (Pittini, 2019).

Indirect impacts.

(1) *Housing, health, and overcrowding*: COVID-19 dealt a blow to housing areas that were already under the most pressure and it has been argued that this points to a need for more social housing (Hilditch, 2020). The link between poor housing and poor health is well established, but commentators have argued that the coronavirus crisis proves that authorities must take action to remedy the situation, as COVID-19 death rates were higher in areas where the housing crisis was worst. While the relatively high death rate is likely to have arisen from a combination of factors including poor air quality, multigenerational homes, and a large number of people working in jobs that continued through the lockdown, there appears to be a correlation between a borough's housing crisis and the number of coronavirus deaths.

(2) *Increased risks at shared accommodations*: COVID-19 dealt a blow to the housing areas under the most pressure, and it has been argued that this points to a need for more social housing (Hilditch, 2020). The link between poor housing and poor health is well established, but commentators have emphasized that the coronavirus crisis proves authorities must take action to remedy the situation, as COVID-19 death rates were higher in areas where the housing crisis was worst. While the relatively high death rate is likely to have arisen from a combination of factors including poor air quality, multigenerational homes and a large number of people in jobs that continued through the lockdown, there appears to be a correlation between the borough's housing crisis and the number of coronavirus deaths (Hilditch, 2020, Kachanoff et al., 2021).

(3) *Homelessness, vulnerability and increasing cases*: Homeless people are vulnerable in general and, with the likelihood of poor nutrition and other possible health complications, are at greater risk of contracting the virus (Mosites et al., 2020). Considering the impact of COVID-19 and the implications for the future, one publication has suggested that the homelessness problem was at a crossroads. These fears about homelessness are legitimate. In London alone, the city council has reported 20 thousand people at risk of homelessness due to economic difficulties (Hilditch, 2020).

1.4 Section summary

Since its emergence late in 2019, the coronavirus pandemic has triggered what is considered the worst public health crisis in a century, with outbreaks spreading to virtually every corner of the globe: first, between interconnected metropolises, then through the urban-rural continuum. Broadly speaking, this research demonstrates the need to learn from the pandemic's many difficult lessons, as well as from the creative and inspiring responses that have been developed to contain COVID-19 and ease its effects. Moreover, it this research also explores the forces that are shaping the future of cities, namely the responses to current and future pandemics, the role of socioeconomic planning in facing new challenges, and the value of creating resilient cities.

Pandemics have affected humanity throughout the course of history. They have greatly influenced societal relations, health systems, city development, and politics (Huremović, 2019). Therefore, it is important to understand the behaviour of the pandemic, and more importantly, to understand its less obvious effects. Measuring the impact of a pandemic is a complicated process, for it means considering both tangible and intangible aspects.

Although researchers have succeeded in identifying several methods for measuring the impact of a pandemic, each method has its weakness. Therefore, there is a need to create a more comprehensive tool for measuring that can recognize the correlation between different characteristics of pandemics. Table 6 compares the strengths and weaknesses of each established method for assessing the effect of pandemics on housing affordability. This will pave the way for the development of a new impact measurement framework (section 2.2).

Table 6. Strengths and weaknesses of affordability approaches, source: Meen, 2018.

Approach	Strength	Weakness
House price to income approach	<ul style="list-style-type: none"> - The required data are regularly published and are available on a broadly comparable basis. - Predictions on this basis are cheap to construct and require few technical skills. - The margin of inaccuracy is negligible and therefore does not reflect direct negative results. - Enjoys global acceptance. 	<ul style="list-style-type: none"> - It reviews the position of the economy as a whole, but it does not demonstrate the position of different groups in society. - In case of economic crisis, mortgage interest rates remain at a low percentage and therefore the price-to-earnings ratios are misleading, overstating affordability problems - There is no clear rationale behind affordability thresholds

Housing expenditure to income approach	<ul style="list-style-type: none"> - Provides a better guide to affordability changes over time since owner-occupier expenditure includes the effects of changes in interest rates. - Reasonably accurate estimation of affordability, since it includes change in expenditure over time. 	<ul style="list-style-type: none"> - Does not address housing quality and adequacy. - Concentrates on economic aspects only. - Erroneously assumes that every family and individual has equal capacity to pay for housing.
	<ul style="list-style-type: none"> - Provides the most accurate estimations of housing affordability when the economic realities are similar for all chosen samples. - Considers the variables of incomes and acknowledges that people have different spending needs. - Considers household structure and different levels of income among different households. - Addresses equity concerns. 	<ul style="list-style-type: none"> - Does not account for the influence of housing quality or location preference on housing cost (no account of location trade-offs). - Creates a certain threshold above which affordability becomes increasingly subjective. - Requires an element of generalization and judgment about the household type.
Housing supply measure approach	<ul style="list-style-type: none"> - Permits a better exploration of housing price dynamics. - Can offer salient information on future evolution trends of housing prices. - Enables the comparison of the effectiveness of housing policy on price trends in various housing units' sizes across cities over time. 	<ul style="list-style-type: none"> - Difficult to interpret and requires a considerable amount of work to prepare and analyse the data required. - Relies on the availability of data from the market directly.

Housing affordability, affordable housing, and social housing are different concepts, yet they all reflect similar goals and objectives. But defining housing affordability is still challenging. This is largely due to the fact that there is no agreed upon terminology to deal with housing affordability; each country uses its own terminology and definitions. Most countries in the European Union, moreover, have not yet developed a legal definition of housing affordability. But despite this uncertainty in the meaning of housing affordability, the indexes used to measure it seem well-balanced and effective. Local

authorities and ad agencies have developed several approaches and methods over time; these measures assess economic, social, environmental, and other aspects of inhabitants' lives.

There is a general agreement among scholars that COVID-19 has both directly and indirectly impacted housing affordability. To understand these effects, one must begin by investigating the indexes associated with them, including household income, expenditures (non-housing and housing-related), housing provisions (housing stock and demands). Additionally, one must also carefully consider other variables such as geolocation and each city's characteristics.

1.4.1 Use and adaptation of investigated literature.

Forming a clear hypothesis, specific research question, and examining the existing knowledge is vital to achieving the aims of this thesis. However, there is a clear need to shape the understanding of the use of the examined literature. Table 7 was prepared with the purpose of identifying the use and interpretation of the examined literature. Keeping in mind, this thesis seeks to form an impacts measurement tool of the pandemic on housing affordability indicators.

Table 7. Investigated literature use and adaptation, source: author, 2021.

Investigation subjects	Investigation scope	Investigation purposes
Pandemic definitions	<ul style="list-style-type: none"> - The differences between pandemic and epidemic. - The definitions of a pandemic by WHO. - The pattern and aspects involved in defining pandemic - The links between pandemic and city formation. 	<p>Form a clear understanding of pandemic meanings and effects on human lives and city formation.</p> <p>To guide the framework to specific measurement methods and conditions (the impacts of the pandemic on the investigation subject).</p>
Responses against COVID-19	<ul style="list-style-type: none"> - Identify the international recommended responses by WHO. - City-scale responses to recover from COVID-19. 	<p>To identify the areas where COVID-19 impacted the most.</p> <p>To formulate recovery recommendations based on an urban scale.</p>
Impacts measurement methods	<ul style="list-style-type: none"> - Investigate the definitions and characteristics of an impact. 	<p>To set the context of the framework and the types of inputs.</p>

Housing affordability definitions and synonymous	<ul style="list-style-type: none"> - Investigate the scientific method to measure the impacts of activity or variable. - Identify the characteristics of the accurate measurement's method. 	To form the measurement steps required to achieve the aim of this thesis.
	<ul style="list-style-type: none"> - Explore the definition of housing affordability in Germany, the United Kingdom, and France as the most populated countries in the EU. - Identify the terminologies associated with housing affordability since this term is not in universal use and varies from one location to another. 	<p>To establish a universal definition of housing affordability to understand the proposed framework scope and method of work.</p> <p>The investigation of various terminologies suggests that housing affordability is most often referred to as “social housing”. Therefore, investigate the aspects and indicators of social housing allocation in the urban fabric is one of the framework points of interest.</p>
	<ul style="list-style-type: none"> - Investigate the various approaches used to assess housing affordability. - Identify the component of affordability approaches to be studied as indicators and indexes. 	Form comprehensive identification of different affordability approaches leading to narrow the investigation scope and set the condition of investigation
Affordability indexes and indicators	<ul style="list-style-type: none"> - Identify the meanings and deference's between index, indicator and variable. - Investigate the classification of indexes and indicators linked to comprehending the meanings and indexes of housing affordability. 	<p>Narrow the investigation scope to the related indicators and indexes only (data identification purposes).</p> <p>Form the base of the framework points of interest to be investigated comprehensively in the study location.</p>

CHAPTER 2: METHODOLOGY AND IMPACTS MEASUREMENT DEVELOPMENT

This chapter identifies the research design, research instruments, and approaches used in this thesis. It explores the most commonly used theoretical and practical methods for understanding pandemics, housing affordability and impact of pandemics on housing affordability, as reviewed in sections 1.3, 1.3.1, 1.3.2. and table 7 taken together, these methods allow us to create a framework for measuring a pandemic's effects – particularly those related to COVID-19 – on housing affordability indexes. This takes us closer to answering this thesis's research question and helps to close the gap between the theory of impact measurement and actual estimation practice.

The progression of this chapter is detailed in Figure 11. It starts by exploring different analytical approaches, indexes, before moving onto the larger methodological framework used in this study. This is followed by a brief summary, forming the starting point for Chapter 3.

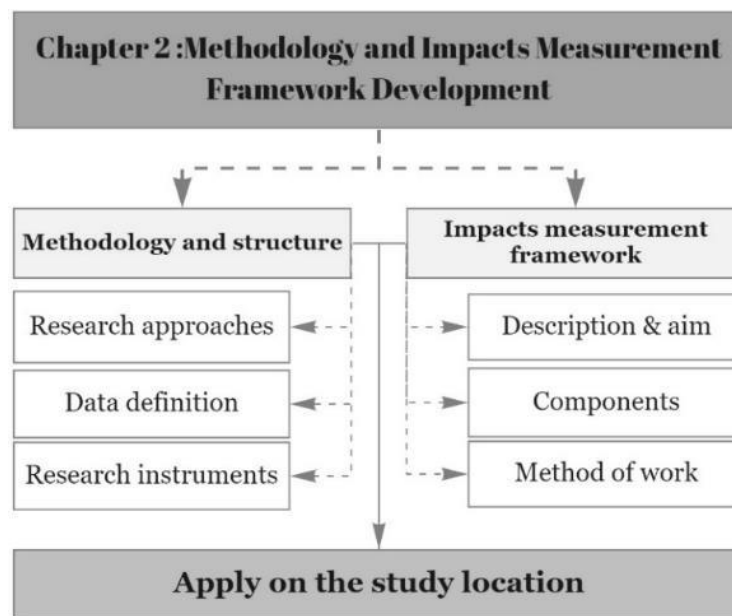


Figure 11. Chapter 2 Structure, source: author,2021.

2.1 Methodology and structure.

A research study is generally defined as a systematic and scientific process to develop cumulative knowledge about a specific subject or prove a hypothesis. The process itself involves the use of theories, observation, plans, experiments, and conclusions, all of which aim to answer the questions of interest and achieve the objectives of the investigation (Weiss, 1979).

The design of this thesis is based on the principles and methods of mixed-approach research. Mixed-use research can be defined as the class of research in which the researcher merges and quantitative and qualitative data, strategies, approaches and concepts into a single study. This combination allows for a deeper comprehension and more complete picture of the investigated issue or

phenomenon (Johnson et al., 2007, Yin, 2006, Bryman, 2006). It also allows one to establishing generalizable facts about a topic, and, in the case of this project, to ultimately form an impacts measurement framework (Figure 12). By its nature, mixed-use research is effective for both sides of this thesis's investigation, first for its theoretical investigation that establishes a basic understanding of pandemics and affordability approaches, and second for its investigation of practices that are widely used to measure the impacts of variables on a pre-set combination of factors – housing affordability, in this case).

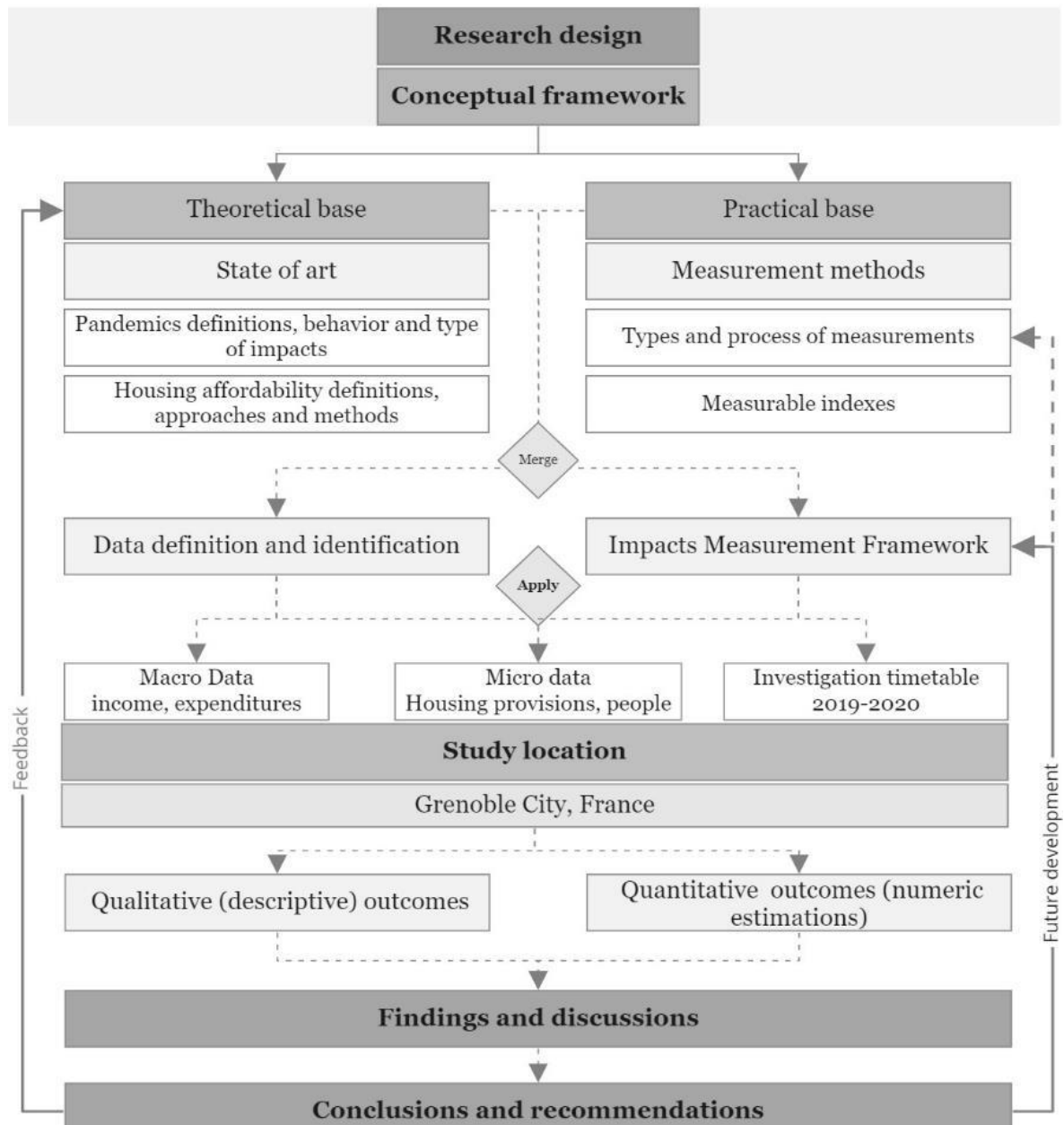


Figure 12. Research conceptual framework, source: author, 2021.

2.1.1 Research approach.

Qualitative approach

Qualitative research means investigating the underlying reasons for an issue, explaining the methods and strategies that can be used to solve an issue, or describing the characteristics of a specific subject (Lewis, 2015). Here, this approach is adopted to develop the theoretical background for the definitions of pandemics, their behaviour, and how they are responded to, as reviewed in section 1.3.1. At the same time, it is used to investigate the meanings of housing affordability, its indexes, and how COVID-19 has affected it, discussed in section 1.3.2. There, a literature review forms the main source of the qualitative data. This data ultimately forms the theoretical base for the subjects of this study.

Quantitative approach

Many scholars have agreed on defining quantitative research as the exploration of phenomena by the use of numbers, values, and statistics (Sukamolson, 2007). Therefore, after compiling qualitative data, including definitions, approaches, and various methods to estimate the effects of a pandemic, this thesis then identifies a suitable method for assessing and calculating these effects, which are presented as a unified process using statistical numeric systems. Such quantitative data has been collected from local descriptive reports and official statistics, as well as those published by the World Health Organization (WHO) and the EU. The data collected and identified according to the investigated indexes align with sections 2.1.2 and 2.1.3.

2.1.2 Investigation context

Establishing a theoretical database that explains and describes the meanings, approaches, and indexes of housing affordability must rely on existing theoretical literature. However, to determine the effectiveness of the framework proposed in this thesis, it is vital to test its applicability in a specific contexts and conditions. To do so, this thesis includes a case study of a specific geographical location, the Grenoble metropole in France.

The selection of this study location was based on the availability of data and the unique characteristics Grenoble, including being one of the largest cities in France, and possessing one of the highest percentages of low-income housing (HLM) in the country (approximately 24% of total housing stock). It also depended on the feasibility of conducting on-site observations, namely by considering the travel and health restrictions that resulted from the pandemic.

The national context – the French republic.

Following the principle of a top-down approach, this thesis begins by examining national affordability indexes that previous scholars have identified, allowing us to develop a general understanding of land tenure and the broader economic landscape. Some indexes, for example, are linked to time fluctuations and natural growth, such the growth of housing prices between 2015 and 2019. Such indexes provide a base for comparison, which is important for understanding the meanings of the data analysed in this thesis.

Although housing planning and the distribution of subsidies are the tasks of local governments, most housing policies are determined at the regional level, coming from central councils, and are based on national data. It is important, therefore, to examine and understand the variation of housing characteristics, and their justifications, on a wider scale.

The local context – the City of Grenoble.

Examining the national context provides a general understanding of the economic aspects of housing affordability. But other indexes, such as social disruption and geospatial themes, cannot be properly studied at the national level. Moreover, examining the city of Grenoble is important to (1) verify the applicability of the proposed framework, and (2) to understand the impact of COVID-19 on affordability indexes between 2019 and 2020.

This study's examination of Grenoble begins with an investigation of its urban structure, namely the different sectors that make up the city, followed by the affordability indicators and indexes in each sector. The data collected at the city level is then compared to national benchmarks. For example, national data suggests that housing prices are constantly increasing. However, in the city of Grenoble, the data shows that prices have stabilized. This is likely due to various reasons associated with income ranges in Grenoble, land limitations, and land use.

2.1.3 Data definition and identification.

Revisiting the theoretical data investigated in the literature review and the conclusion of table 7, this section identifies the types of data, the methods used to collect these types of data, and the data's role in framework for measuring a pandemic's impact on housing affordability.

Both secondary and primary data were used in the preparation of this research. The secondary data were collected from descriptive reports, statistical reports, scientific literature reviews. The main sources of the primary data were visual analyses of maps based on pre-post time parameters, and an analysis of a geographic information system (GIS) database.

This research has identified five types of data that are needed to create a framework that can process affordability indexes and the effects of a pandemic in order to assess and measure the impacts of pandemics on affordability (Table 8).

Data limitation and availability

Some of the required data were missing during the time of investigation specifically (housing reports for 2020), the unavailability of data is the result of annual statistics publication dates, where economic outlook and housing reports are annually published usually in October and December, and due to the current health context, some of these reports were postponed or published without the required data. Alternatively, a QGIS database was obtained from the municipality of Grenoble containing all types of buildings status and construction conditions, which translated to data about housing stock and geospatial allocation of housing types.

Another approach to overcome the data shortage was adapted for specific sets of data, such as

the rent price per square meter in the national context, where a simulation and prediction tool was used; the tools project the market price for the future based on the data of the past 10 years. However, the result might change, and the accuracy is decreased, yet it is considered the closest to the actual needed data.

Table 8. Research data identification, source: author, 2021.

Type	Category	Source/database
Household income	Fixed income per household	<ul style="list-style-type: none"> • Eurostate.
	Other income per household	
Non housing expenditures	Expenditure per household	<ul style="list-style-type: none"> • OECD¹ Economic
	Temporary expenditure per household	<ul style="list-style-type: none"> • DataStream².
	Cost of rent per month/ per year (cost per square meter)	<ul style="list-style-type: none"> • ECRF³: Lending to Households.
Housing expenditures	Cost of utilities and services	<ul style="list-style-type: none"> • EU-SILC⁴. • INSEE⁵.
	Total available units or existing housing units	<ul style="list-style-type: none"> • QGIS⁶ Open street map. • INSEE.
Housing provisions	Total planned and under-construction housing units	<ul style="list-style-type: none"> • Data metropolefrance⁷. • Opendata-
	Total units required by applicants	Auvergnerrhonealpes
Targeted group and locations	Type of population targeted.	<ul style="list-style-type: none"> • QGIS Open Street map.
	Geospatial allocation of housing	<ul style="list-style-type: none"> • Manual visual analysis (pre-post systematic analysis).

¹ Organization for Economic Co-operation and Development.

² DataStream is a global financial and macroeconomic platform, providing data on equities, stock market indices, currencies, company fundamentals, fixed income securities and key economic indicators

³ The European Credit Research Institute (ECRI) provides data on credit to households, including outstanding consumer credit, loans for house purchases, loans to non-financial corporations and annual household consumption expenditures

⁴ EU Statistics on Income and Living Conditions provides data on income, poverty, social exclusion and living conditions in the European Union

⁵ The National Institute of Statistics and Economic Studies.

⁶ Quantum Geographical Information System provides data on spatial planning and buildings allocation.

⁷ Provides data on building permit, construction status and housing allocation.

2.1.4 Research instruments

In addition to investigating theoretical, secondary data that describes, classifies, and defines the indexes of housing affordability, and the way that these relate directly to the effects of pandemics, this thesis has engaged in a close study at specific geographical locations to define and formulate the primary data, as described below.

(1) *Urban formation context*: The study and analysis of geographical locations in terms of housing types, housing provisions (the distribution of existing houses and those under construction), and population classification per economic class, including those with low or middling incomes.

(2) *Housing affordability context*: The process of collecting, categorizing, and analysing the actual data collected in the context of a specific city. To that end, this thesis has used the following instruments and methods to collect the primary data described in the data definition section.

GIS database

One of the most important tools for collecting and organizing data was the GIS database, which provides multilayer information statistics that include building typology, areas classification, plot identification, physical conditions, and building permits status.

Field observation and visual analysis (geo-mapping)

In several cases, the GIS database did not provide enough information about building conditions and construction status; therefore, a visual analysis was carried out based on a one-year comparative basis to identify the types and locations of new construction.

2.2 Pandemic Impacts Measurement framework development.

Although many scholars, organizations, and agencies have already established frameworks and methods for measuring the affordability of housing, these are insufficient in two main areas. First, these methods focus on specific characteristics, which are often driven by economic reasoning such as income, expenditures, or market value. Second, none of these methods (as explored in section 1.3.13 and 1.3.2.2) see the pandemic as a variable to be considered in the planning and measuring of housing affordability in long or short term.

As such, it is necessary to create a comprehensive and universal framework that sees affordability from a different point of view; it should be understood as a transdisciplinary concept, drawing from economics, social sciences, and urban planning. This is essential for improving the responses of cities and societies to pandemics, whether the existing COVID-19 pandemic or future ones. Figure 13 lists the various aspects that make up the pillars of Pandemic Impacts Measurement (PIM).

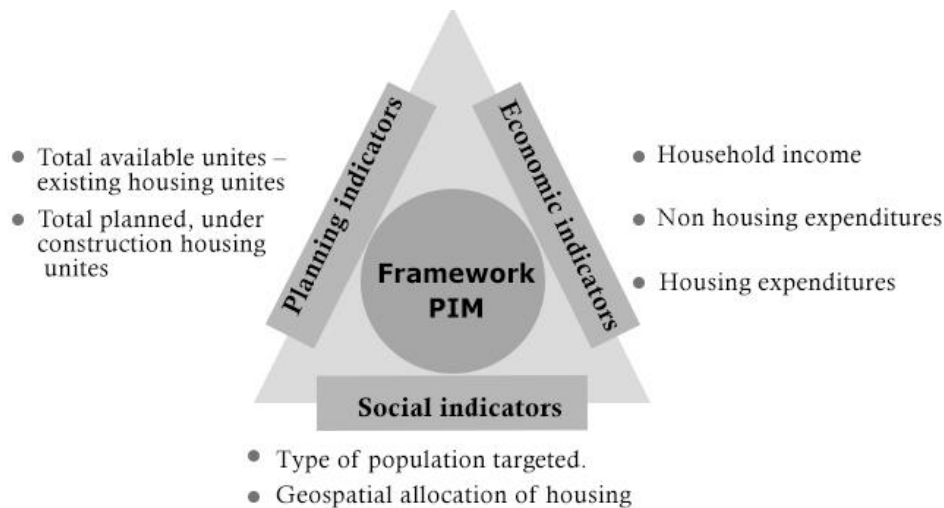


Figure 13. Pandemic Impacts Measurement (PIM) pillars, source: author,2021.

2.2.1 Framework description and aim

The term “framework” is vast by its definition; it aims to explain and support a process or a concept or prove a hypothesis (Godfrey, 2019). This definition is the starting point for understanding this thesis’s proposed framework, “Pandemics Impacts Measurement.” This framework is used to understand the meaning of pandemics, the various methods used to measure an impact, the methods used to analyse affordability, and to understand the different indexes that control and establish affordability indicators.

Although the main idea behind this framework seems simple, it works at different levels. To clarify its intent, it is first important to understand affordability as a measurable concept that is viable when translating descriptive data into a mathematical representation. In doing so, this framework requires identifying all affordability indexes impacted by COVID-19, as identified in section 1.3.2.2, and then measuring the increase or decrease of affordability indicators at a specific location in association with official economic, social, and planning statistics.

The study’s aim is to create a unified and universal framework that can help to measure the impacts of the pandemic on housing affordability. At the same time, it works to answer the main question of this research: how do we measure the impact of COVID-19 on housing affordability? The uniqueness of this framework results from viewing housing affordability as an impactable index that requires a measurement to determine reasonable responses to the deterioration of affordability during and after pandemics.

This framework uses pre-post comparative analyses to measure the impact of a pandemic. At several variable of affordability indexes, this framework uses a mixed approach, merging both counterfactual analyses and borderless analyses, as described in section 1.3.1.3. These types of analyses were selected because of their suitability for carrying out pre-post data analysis and their capacity for including uncontrolled variables such as time and location.

2.2.2 Applicability and effectiveness

This thesis uses the Pandemic Impact Measurement (PIM) framework to investigate the impacts of pandemics on housing affordability by relying on specific indicators. These indicators were selected to assess housing affordability and the connection between pandemics and these indexes. To make this thesis's framework more dynamic, however, other variables and indicators could be included, affecting the purpose, scope, and even aim of the investigation. Social aspects, for example, were not part of the original investigation's scope; therefore, this framework could be expanded to include and target specific groups such as middle-income and low-income populations.

The PIM framework is a method of operation rather than a strict tool, meaning that its potential use goes beyond the limits of the thesis. For example, it could be used to compare different time periods, different cities, and even different sectors within cities to one another. This would simply require adjusting the investigation's purpose and identifying the relevant indexes for the subject.

Why do we need such a framework? This thesis suggests that there is a need to establish a universal method for assessing the impacts of pandemics and the variability of the housing situation in specific locations and times, even when authoritative approaches have been adopted to ensure affordability. The core principles of PIM are simple. It identifies a problem, considers its context, and then investigates the variables using a pre-post comparative approach.

2.2.3 Components.

The proposed framework comprises two main components, each serving a specific purpose (Figure 14). The first and most important component includes input data.

Pre- and post-pandemic quantitative input data: Composed of the indexes, written as numerical values, which have been expanded to include (1) fixed income per household per month/year, (2) other income per household, (3) total fixed expenditure per household per month/year, (4) temporary expenditure per household, (5) cost of rent per month/year (per square meter), (6) cost of utilities and services per month/year, (7) total available units and existing housing units, (8) total planned or under-construction housing units, and (9) total units required by applicants.

Pre- and post-pandemic qualitative input data: Includes the descriptive (social) data such as (1) type of population targeted, and (2) geospatial allocation of housing.

Affordability benchmark: Although the purpose here is to establish a comparative base for pre- and post-pandemic affordability indicators, it is important to set a benchmark that serves as the baseline for judging affordability. Affordability benchmarks vary from one method to another, and are usually represented in various forms, yet the most common form is the cost to income ratio.

Cost (housing and non-housing) to income ratio: There is currently a metric used to measure housing affordability, the 30% housing cost-income ratio (Md, 2015). This metric indicates that households spending more than 30% of their income on housing are likely to experience housing affordability challenges. Though easy to understand, it does not indicate if a household can afford basic

non-housing expenses like food and transportation after paying for housing (OCED, 2020).

Analysis procedures: This refers to the mathematical, systematic process of collecting and analysing the data from pre- and post-pandemic indexes. This is described in greater detail in section 2.2.4.

Output data: The result of collecting, categorizing, and analysing the data. These data are presented in the form of percentages and compared to the applicable benchmark, which varies based on location. The output data include the same sets of quantitative and qualitative data identified under input data.

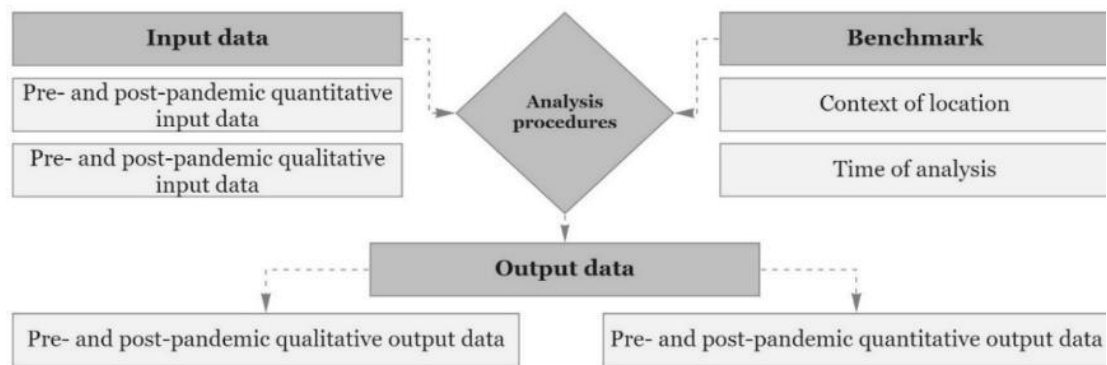


Figure 14. PIM components, source: author,2021.

2.2.4 Method of work

The PIM framework used in this thesis is a systematic process that organizes actions and processes and translates them into multiple steps with clear descriptions and the requirements for executing each of these steps (Table 9).

Table 9. PIM method of work, source: author, 2021.

Phase	Steps	Purpose and process.
Pre-analysis procedures	Motives identification: Why are we doing it?	Set the motives for analysing as academic, professional, or monitory. This will help to guide the writing and analysis according to a specific theme and style.
	Intention clarification: Why is it important?	Describe the reasons for adopting the framework and the expected outcomes.
	Data identification: What is needed?	List the data, both primary and secondary, required to conduct the analysis, along with its collection method, categorization, and treatment, as identified in section 2.1.2.
	Conflict and limitation identification	Clearly list the limitation of the study such as time, location, and data variables. At the same time,

Analysis procedures		conflicts of interest must be identified; these conflicts arise when the best interests of the research conflict with the best interests of another person or organization.
	Secondary data validity and exclusions	This framework depends heavily on the availability and accuracy of quantitative secondary data, therefore selected data must meet the criteria identified in Table 5.
	Primary data creation	Social indicators and geo-spatial data are not available in secondary data sets, therefore adopting a geo-spatial formula will require software such as GIS or QGIS.
	Mathematical calculations and correction process	<p>A series of mathematical process to treat and analyse the identified and collected data. This mathematical process includes several formulas, including:</p> <p>* <i>[Affordability ratio = rent / income]</i></p> <p>* <i>[Consumers' expenditure (excl. housing) + housing costs + saving from current income = post-tax household earned income + post-tax income from net financial assets]</i></p>
	Comparative and benchmarking process	The result of the mathematical calculation does not reflect the impact of an event. Rather, it shows the condition of housing affordability and therefore must be compared to the results at different periods, whether by using ten-year averages or year-to-year averages.
Result filtration and validation procedures	Result categorization	<p>Where the indexes are not clearly identified, the result might reflect different sets of data, therefore a categorization process is required that complies with the affordability indexes and indicators identified in section 1.3.2.2.</p> <p>The categorization of results should follow the same structure of the input data, both as qualitative and quantities results.</p>

Outcome's syntheses procedures	Result integrity	The researcher must be honest and show a consistent and uncompromising adherence to strong moral and ethical principles and values; therefore, the result must align with the conflicts and limitations identified and clearly mentioned in the pre-analysis phase.
	Treatment of quantitative and qualitative results	Obtaining the data from the analysis procedures requires a treatment that starts with the association of the result with its index, then moves to the translation the data from numeric values to descriptive values, and finally the presentation of results in the format of descriptive reports or numeric statistics.
	Comparison against original motives	During the analysis process, the original motive might shift or be altered due to the exposure of the researcher to the data, therefore keeping the objectivity of the research is important, and referring to the original motive and intentions is important for maintaining the integrity of the results.

CHAPTER 3: CONTEXT AND STUDY LOCATION

The aim of the Pandemic Impacts Measurement framework (PIM) is to establish a clear method for measuring the impact of pandemics on housing affordability. This chapter applies that method to a specific geographical context, namely Grenoble city, the capital of the Isère department in the Auvergne-Rhône-Alpes region, eastern France.

This section follows the general structure shown in Figure 15. It begins by identifying the overall impact of COVID-19 on housing affordability indexes.

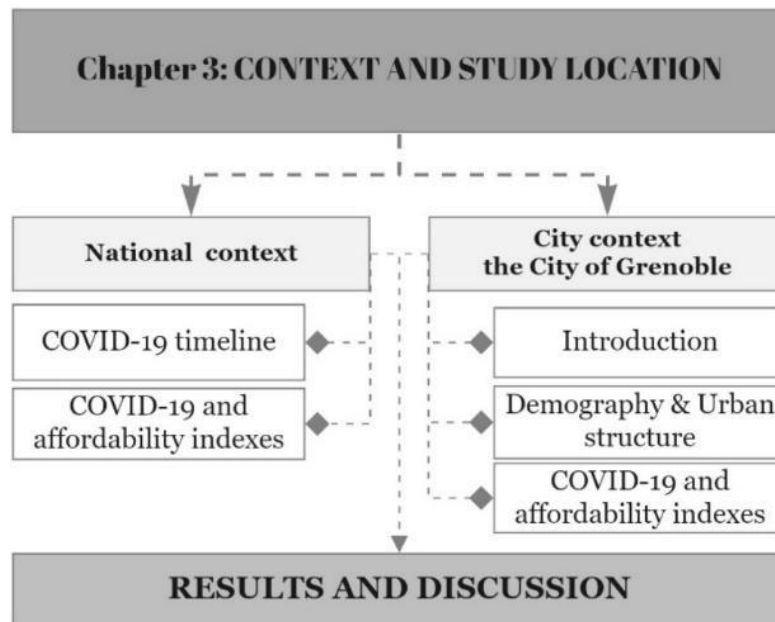


Figure 15. Chapter 3 structure, source: author, 2021.

3.1 National context.

COVID-19 timeline

Following the timeline of COVID-19 in France is important for understanding the rapidity and effectiveness of responses (Figure 16). The virus was confirmed to have reached France, and by extension Europe, on 24 January 2020, when the first COVID-19 case was identified in Bordeaux (Stoecklin et al., 2020). On 4 May 2020, retroactive testing of samples in one French hospital showed that a patient was probably already infected with the virus on 27 December 2019, almost a month before the first officially confirmed case. On 16 March 2020, the government announced a mandatory home lockdown for 15 days starting at noon on 17 March 2020. This lockdown was extended twice and, after progressively easing restrictions and making face masks available to all citizens, ended on 11 May 2020 (Stoecklin et al., 2020).

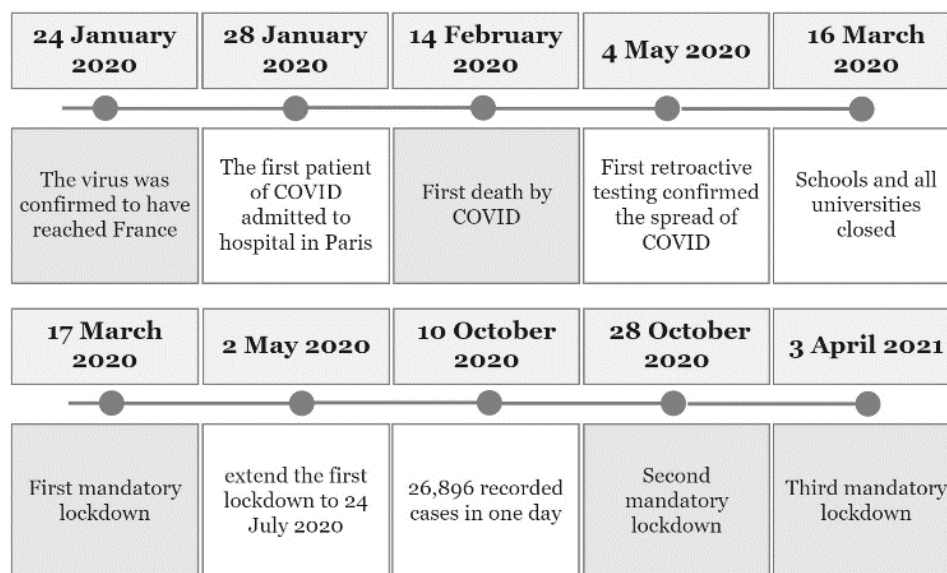


Figure 16. COVID-19 timeline in France, source: WHO,2021.

As of 30 June 2021, France has listed 5,772,844 cases of novel coronavirus. Furthermore, 111,057 people have succumbed to the disease as of the same date (Figure 17).

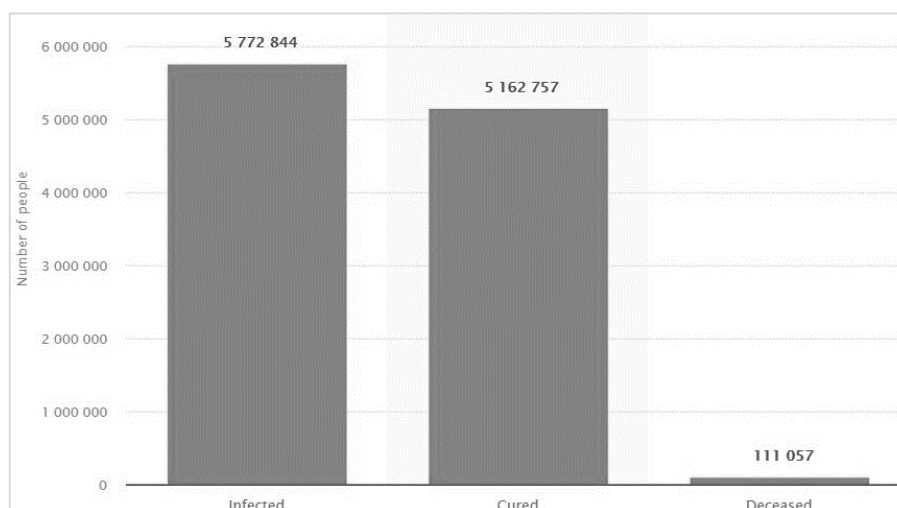


Figure 17. Number of people infected, deceased and cured from the coronavirus (COVID-19) in France as of June 30, 2021, source: INSEE, 2021

COVID-19 and affordability indexes review.

Like all other European countries, the French Republic was hit hard by COVID-19; the continuous lockdowns, movement restrictions, and border closures have contributed to worsening the impact of COVID (Stoecklin et al., 2020). But identifying the impact of the pandemic on affordability indexes is tricky; it requires focusing on the data and indexes identified earlier, which are part of several interconnected statistics. Therefore, to clearly measure COVID-19's impact on affordability indexes, the following section looks at its effects on individual macro data categories including household income and non-household expenses

Household income

Due to the health crisis and the cessation of all "non-essential" activities, the average household's gross disposable income (GDI) has decreased since the beginning of the year (INSEE, 2020).

Fixed income

The decline in disposable income, when combined with the drop in total earned income and, to a lesser extent, property revenue, was significantly less severe than the decline in overall activity. Earned income shrunk by 4.9% per cent in 2020 (table 10), owing to job losses and reduced working hours caused by absences for sick leave and childcare, a reduction in overtime, and the introduction of the short-time working scheme (INSEE, 2020).

Table 10. Household gross disposable income – fixed income, 2019,2020, source: INSEE,2020

Gross disposable income (100 %)	2019				2020				2019	2020
	T1	T2	T3	T4	T1	T2	T3	T4		
	0.9	0.2	0.8	0.9	-0.3	-2.3	1.2	0.4	3.1	-0.2
<i>Earned income</i>	1.1	0.4	0.7	0.5	-2.1	-9.7	7.9	0.4	2.6	-4.9
<i>Gross wages and salaries</i>	1.2	0.5	0.8	0.5	-2.4	-10.0	9.0	0.8	2.9	-4.7

Other income

Other types of income, including income from selling or renting properties and from land benefits, have been affected by the pandemic as well. This suggests that housing issues have even impacted middle-class household (table 11).

Table 11. Household gross disposable income – other income, 2019,2020, source: INSEE,2020

Income per type	2019				2020				2019	2020
	T1	T2	T3	T4	T1	T2	T3	T4		
<i>GOS¹ of sale proprietors</i>	0.3	0.0	0.4	0.6	-0.1	-7.8	-0.4	-3.8	0.4	-6.4
<i>Social benefits in cash</i>	1.4	0.4	0.6	0.3	2.3	7.9	-4.3	-0.7	3.1	6.5
<i>GOS of « households by land »</i>	-0.2	0.0	0.2	0.5	0.0	-1.3	3.1	0.6	0.2	1.2
<i>Property income</i>	1.3	0.0	-1.1	-2.2	-3.7	-2.9	-2.2	-1.4	3.9	-9.2

Non-housing expenditures

The same method can be applied to non-housing expenditures to calculate the consumer price index (CPI). The CPI is defined as the change in a basket of goods and services that specific groups of households typically purchase. It includes living costs such as food and energy and is measured by looking at the annual growth rate using 2015 as the index (OCED, 2021a). Figure 18 shows the radical fluctuation of the CPI; after a sharp decline during the first quarter of 2020, the CPI recovered only

¹ Gross Operating Surplus

slightly during the second quarter before continuing to fall. (OCED, 2021a).

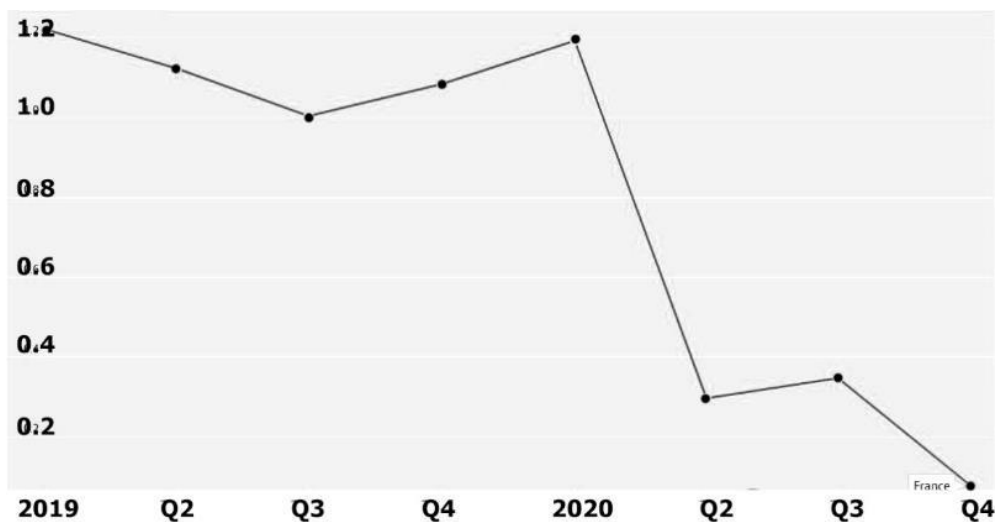


Figure 18. CPI total, Annual growth rate (%), Q1 2019 – Q4 2020, source: OCED,2021

According to the National Institute of Statistics and Economic Studies (INSEE), another way to measure the pandemic's effect is to calculate the expenditure ratio per household, and to compare it to the national baseline from 2015. This suggests that the actual cost of the services, such as water, electricity, gas, domestic heating, healthcare, transport, social protection, and communication, in addition to the cost of consumer goods, such as food, clothing, catering, and other general spending, have increased. (Figure 19).



Figure 19. Consumer price index change, 2015=100, 2019,2020, source: INSEE,2021

Housing expenditures

Rent price

The price-to-rent ratio can be taken as a measure of the profitability of house ownership. It is calculated by dividing the nominal house price index by the housing rent price index. The price-to-income and price-to-rent ratios are indices with a base year of 2015 (OCED, 2021b). Figure 20 shows a

clear and rapid increase in housing prices at the national level, mostly by the increase of saving by individual and therefore the increase of demand.

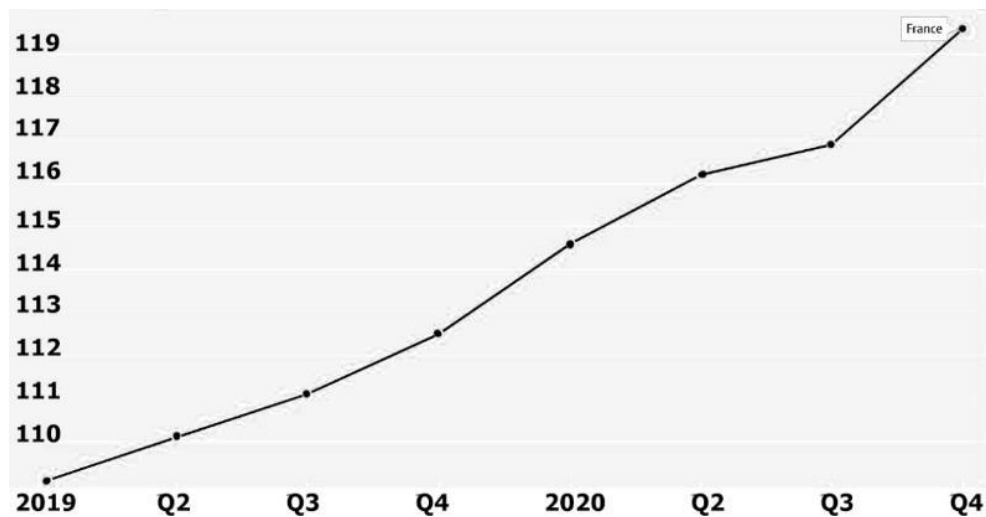


Figure 20. Rent price, 2015=100, Q1 2019 – Q4 2020, source: OCED,2021

Rent price per square meter

The data for rent prices are established up to the end of 2019. After that, the data is based on a computational simulation generated by Cityzia; these data have been merged and presented together, the two sources being distinguished by colour in the chart (Figure 21). In 2019, the average rent was 5.87 euros per square meter, while predictions suggest that rents could rise to 6.18 euros by the end of 2021.

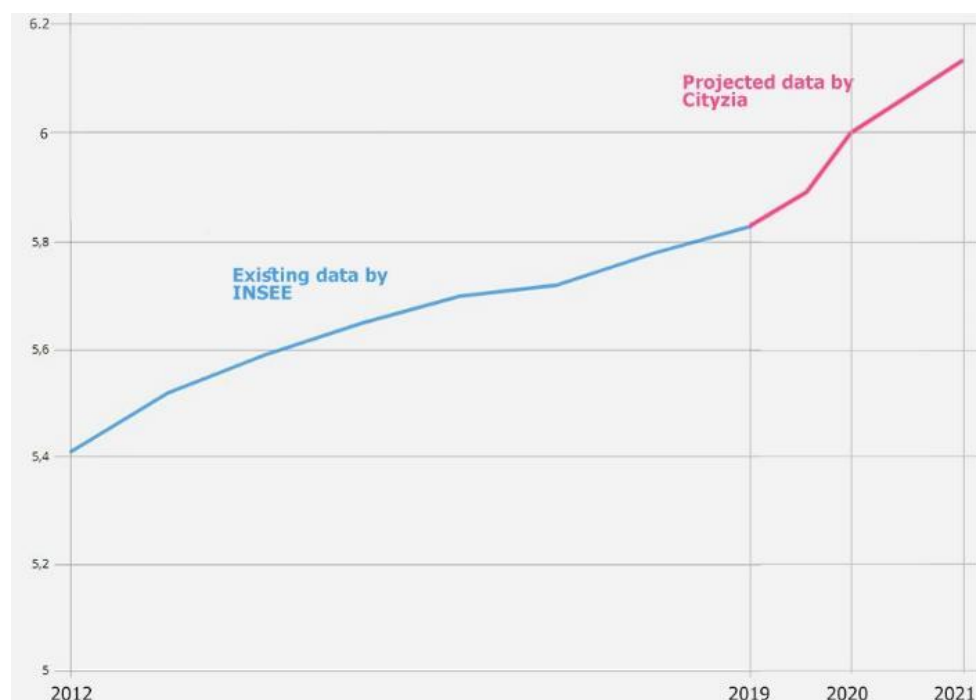


Figure 21. Average rent euros per meter squared, source INSEE, 2019 and Cityzia,2021.

Price to income ratio

The price-to-income ratio is the nominal house price index divided by the nominal disposable income per head; it can be considered as a measure of affordability (OCED, 2021b). A clear increase is observable between Q4 2019 and Q4 of 2020, where the highest indication was on Q2 of 2020 (Figure 22)

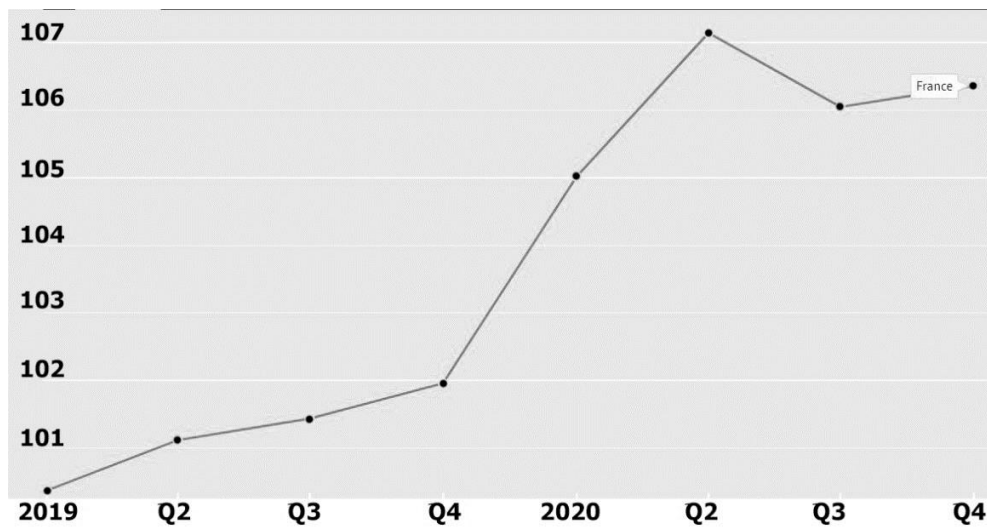


Figure 22. Price to income ratio, 2015=100, Q1 2019 – Q4 2020, source: OCED, 2021

Real house prices

The real house price index is expressed by the ratio of the nominal house price index to the consumers' expenditure deflator in each country (OCED, 2021c). like all other variables related to the economy, the houses prices increased rapidly from 0.6% in 2019 to 1.4% in 2020 (Figure 23).

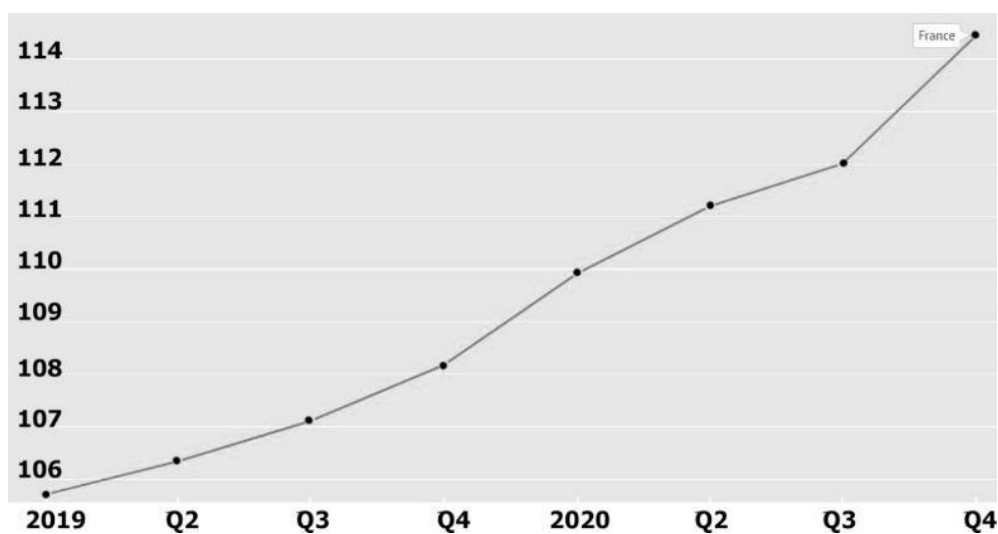


Figure 23. Real house prices, 2015=100, Q1 2019 – Q4 2020, source: OCED, 2021.

Housing provisions

Housing stock – all types

A steady growth in housing stock is observable in metropolitan France (Figure 24). An average growth of 2.1% per year was recorded between 2018 and 2020. Moreover, 37 million housing units were available in 2021, compared to 36.6 million units in 2019 (Arnold, 2019, Arnold, 2021).

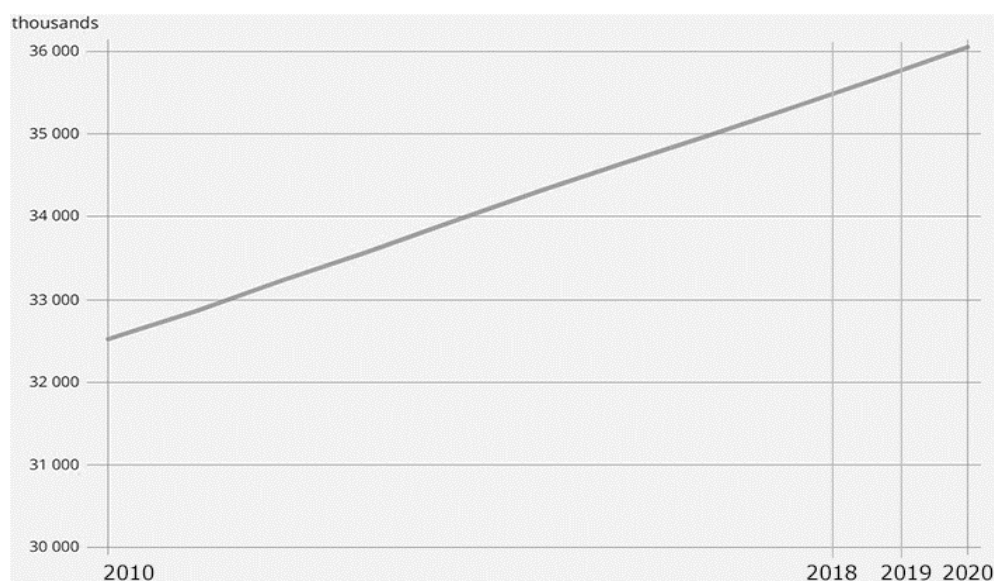


Figure 24. Annual estimate of housing stock - Total number of dwellings - Metropolitan France, source: INSEE,2021.

Housing stock – social housing

Social housing on average makes up between 15.9-16.01% of the total housing stock. The data shows fluctuations in the amount of social housing stock, whether new builds, acquisitions, or renovations (Figure 25).

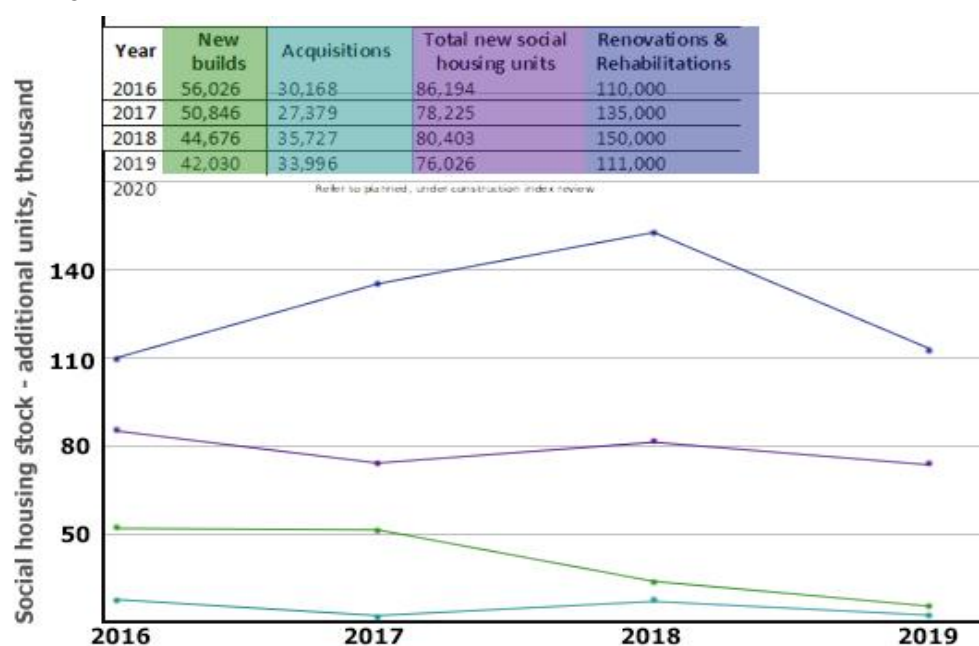


Figure 25. Social housing stock by type, 2016-2019, source: OECD,2021, INSEE,2020, and USH – ‘Chiffres clés du logement social’, 2019.

Total planned and under-construction housing units

Lockdowns in France were not the sole hindrance to production of social housing in 2020. Planning capital investments, including in social housing, became challenging as municipal elections took longer than expected, especially in large metropolitan centres where “run-off” elections were usually required. As a result, *L'Union sociale pour l'habitat* (USH), which had once anticipated authorizing the construction of roughly 110,000 additional social housing units in 2020, now estimates that just 95,000 were allowed—a 15,000-unit shortage (Europe, 2021).

3.2 Grenoble City.

"... at the end of each street, a mountain" (Henri Beyle, Stendhal).

The Grenoble-Alpes Metropole is located in the department of Isere in the south-eastern France, a relatively short distance from the Italian (70 km) and Swiss (110 km) borders. The city of Grenoble is distinguished by its geographic characteristics, which includes mountains, rivers, and agricultural lands. It is situated in a valley between four mountains ranges, (1) the Vercors to the west and southwest, (2) the Chartreuse to the north (3) Belledonne to the east and, (4) Taillefer to the southeast (Paysage, 2016, ephemeride, 2018). Grenoble was originally built at the foothills of the Bastille, around the confluence of the Drac and Isère rivers (Figure 26).

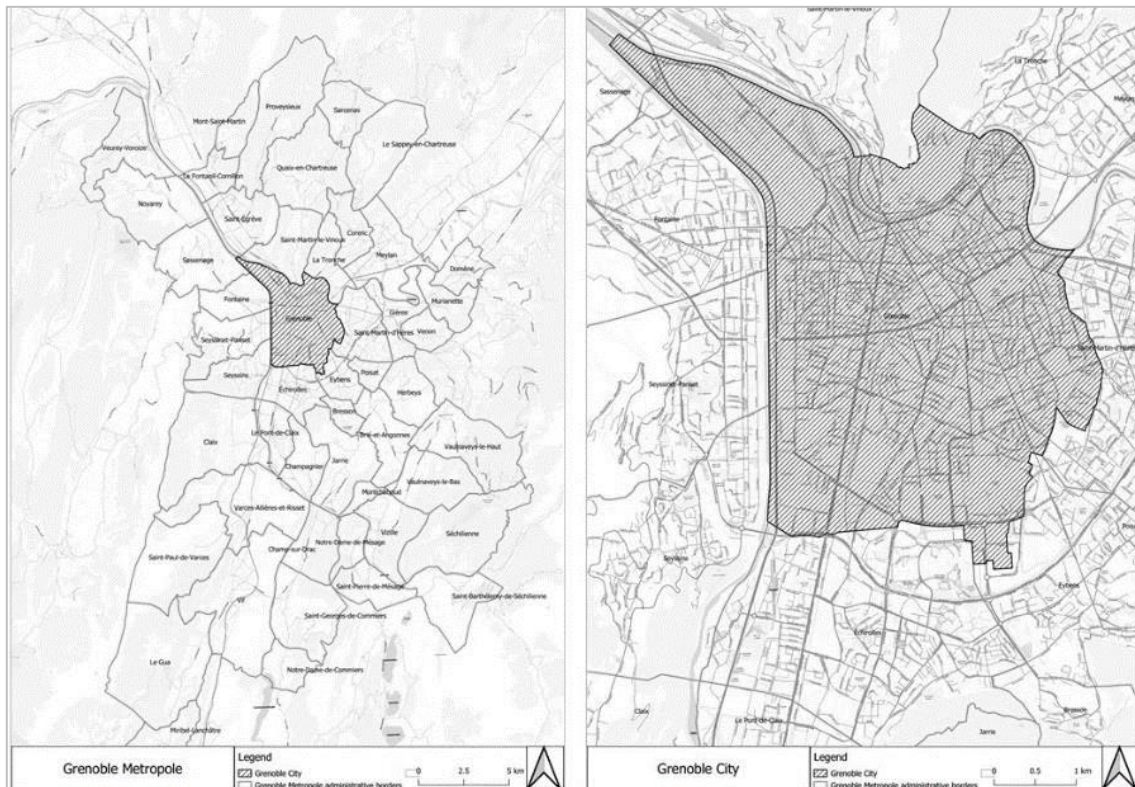


Figure 26. Grenoble city location, source: author, 2021.

Grenoble city is the most populous inter-municipal body in the Auvergne-Rhône-Alpes region; its history can be traced back to 43 BC, and until 381 AD it was called Cularo, or Cularone. The city itself is composed of six administrative sectors, each with its own unique heritage sites, technology, and research-dedicated neighbourhoods, as well as an industrial area. Together, these contribute to Grenoble's uniqueness as a city.

Demography.

The population of the City of Grenoble experienced robust growth during the 19th and 20th centuries due to the city's industrial development, especially after the Second World War and during the 1960s (Figure 22). This growth then declined sharply until the end of the 1970s. Since then, the population has grown steadily. In 2014, Grenoble was the third densest city-centre in France, after Paris

and Lyon, with 8,868 inhabitants/km². This is mainly due to the relatively small size of the municipality (18.13 km²) in comparison with towns of similar size (except for Nancy and Rouen). The total population of the city in 2018 was 157,650 (INSEE, 2018).

Urban structure

According to the Corine Land Cover (CLC)¹, Grenoble is composed of urbanized areas (58.2%), industrial or commercial areas and communication networks (29.1%), non-agricultural green spaces (5.6%), bodies of water (3.8%), and forests (3.3%) (CLC, 2018).

The city is composed of six sectors (Figure 27), each sector possessing unique characteristics and its own rich history of development. Sector 1 is the centre of technology and research in the city, with its vast technological research laboratories and nuclear reactor research centre, while the Sector 2 forms the heart of the old city and extends to the heritage sites at the borders of the city, including the fort on the mountains. Sector 3 is an industrial area and forms the gateway to the Échirolles agglomeration. Sector 4 arose during the city's transitional phase of the late 1960s, after Grenoble was selected to host the Winter Olympics in 1968. Finally, Sectors 5 and 6 are high-residential areas with the largest number of towers and modern developments.

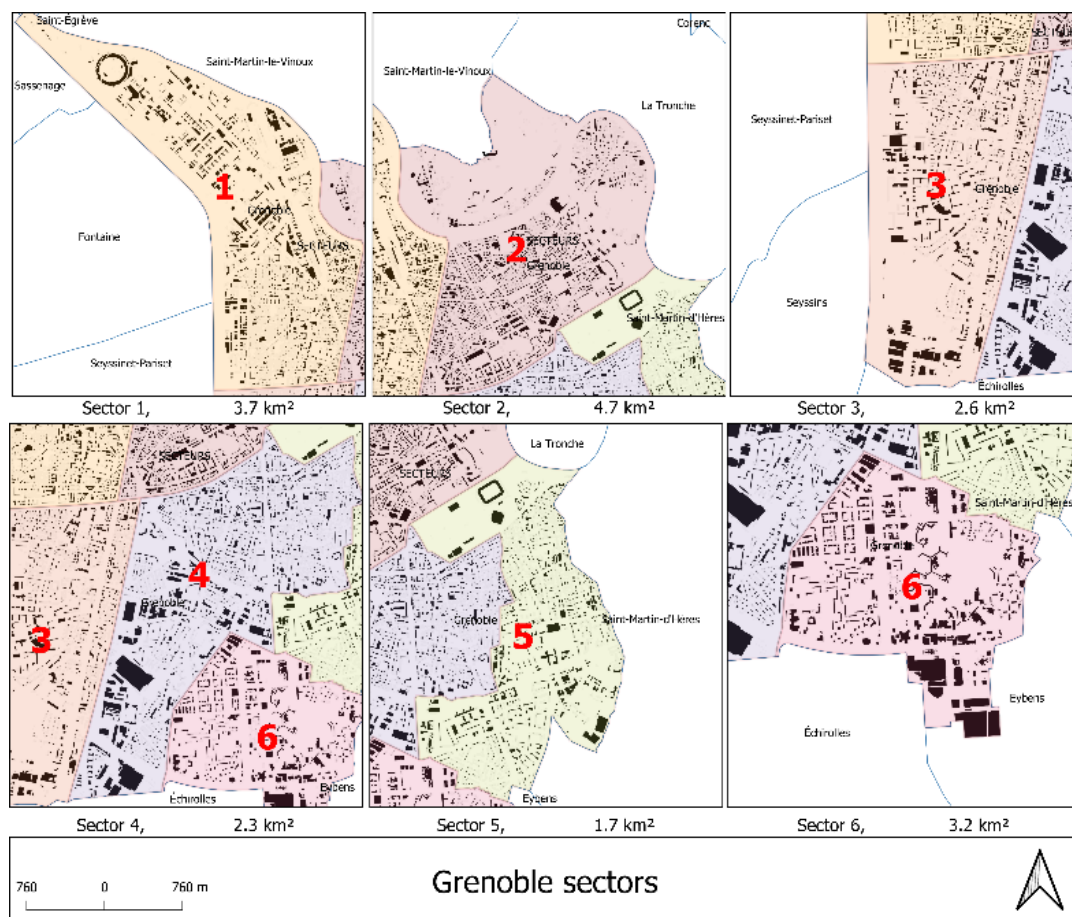


Figure 27. Grenoble city administrative sectors, source: author, 2021.

¹ Corine Land Cover (CLC) is a European database of biophysical land use

COVID-19 and affordability indexes review.

Grenoble has suffered the same consequences of COVID-19 as other cities, including a full lockdown, reviews, business closures, and movement restrictions. All these have affected affordability indexes. Before turning to those, however, it is worth mentioning that some data were inaccessible at the time of this study; therefore, some of the indexes have been reviewed only in their pre-covid forms.

Household income

Fixed income

Statistics from 2018 show that half of Grenoble's population lives on an annual disposable income is slightly over € 20,000, or about € 1,700 per month. Grenoble has the second highest disposable income per capita (CCAS, 2019, INSEE, 2020). The highest incomes are recorded at the city centre, where the average annual income is € 24,000 (Figure 28). However, due to the absence of more recent statistics about incomes, this thesis has adopted a simulation-based method; this predicts a steady income for most of the city except in some areas where the income is expected to increase due to a growth in entrepreneurship and small businesses as well as the completion of several development projects ahead of the pandemic.

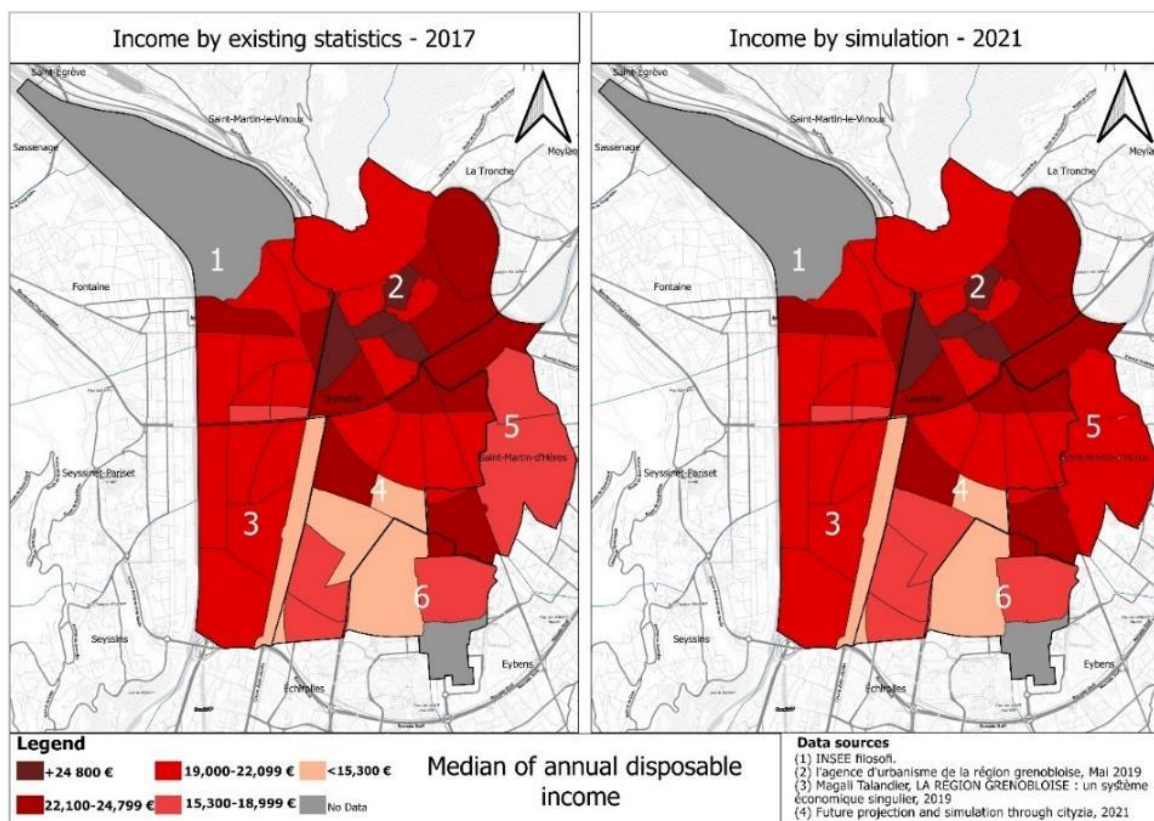


Figure 28. Median of annual income in Grenoble by sector, source: INSEE,2019 , Talandier, 2019, Cityzia,2021.

Non-housing expenditures

Aligning with national trends, Grenoble showed a slight increase in non-housing expenditure during Q4 of 2019 and Q1 of 2020 (Figure 29). This was mostly due to the suspension of non-essential work and the temporary increase of the cost of services such as water, electricity, gas, and domestic heating (though they decreased again in Q3 and Q4 of 2020). Meanwhile, other costs, such as healthcare, remained steady until the outbreak of COVID-19. In Q1 of 2021, however, there was a rapid increase in expenditure, reaching levels not seen since the beginning of the pandemic (INSEE, 2020).

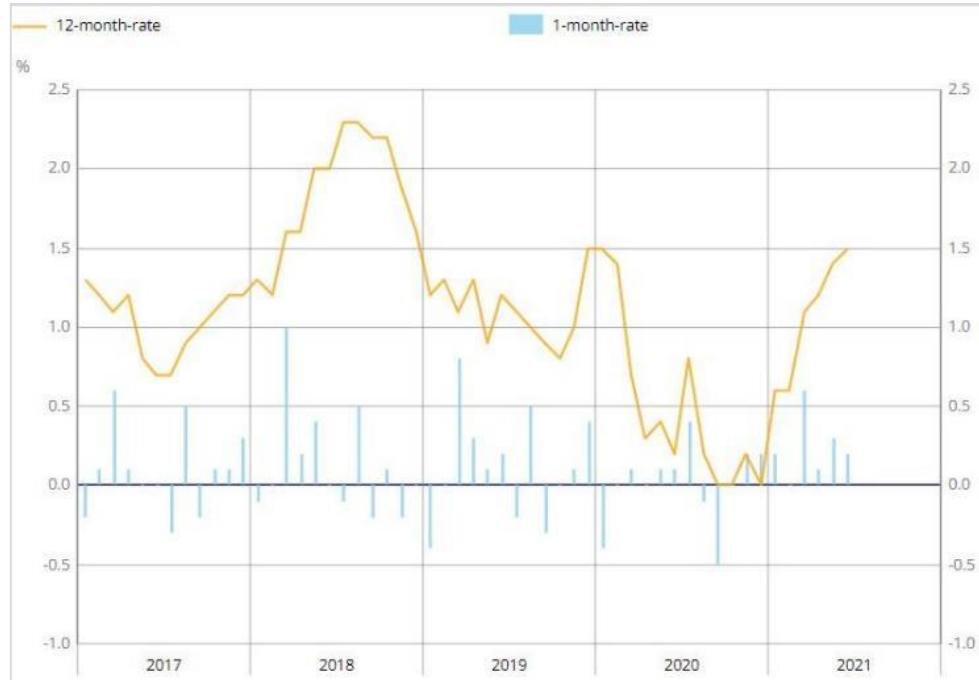


Figure 29. Consumer price index change, 2015 as baseline, 2017-2021, source: INSEE, 2021

Housing expenditures

Rent price per square meter

The rental market in Grenoble is more rigid than surrounding cities. During the three years analysed by the *Observatoire local des rentes* (OLL), Grenoble exhibited the highest level of cost per square meter. In 2018, rents in the Grenoble metropole ranged from € 10.6 € / m² to € 12 / m². In 2019, rents increased by an average of € 0.1 though falling by the same amount in the city centre (Figure 30) (CCAS, 2019).

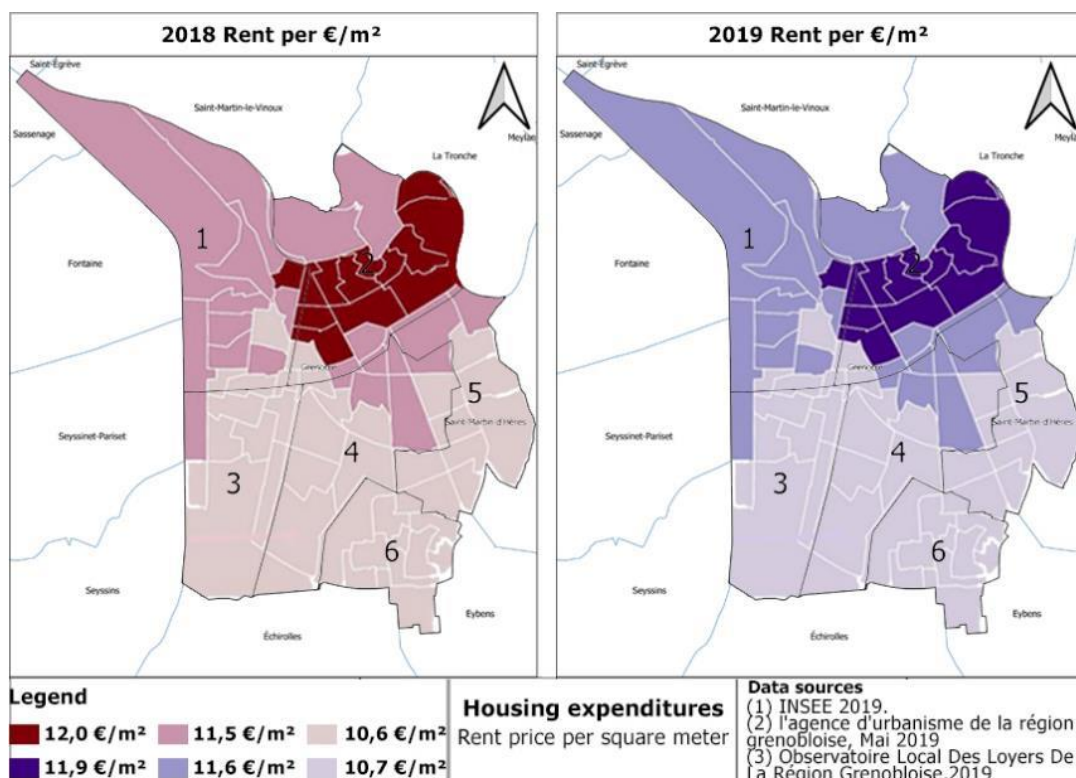


Figure 30. Rent price per square meter, source: INSEE, 2019, OLL, 2020.

Sale prices

Although sale prices slightly increased between 2019 and 2020, the price of old homes in Grenoble has been decreasing since 2012. The real estate observatory of the Chamber of Notaries of Isère also points out that the average time it takes to sell an apartment has increased since the end of the 2000s, which is a sign of a less dynamic market.

In November 2019, the median price of an apartment in an old building in Grenoble was € 2,130 / m², similar to the prices found in the metropolis and slightly higher than those of the Isère department more generally (€ 2,050 / m²). Like the rental stocks, the median sale prices of new housing were higher: € 3,920 / m² in Grenoble, € 3,335 / m² in the metropolis, and € 3,400 / m² in Isère. Despite this downward trend, Grenoble has the highest prices per square meter in the metropolis: half of the old apartments sell for an average price of € 1,510 / m² in Fontaine and € 1,870 / m² in Saint-Martin-D'Hères. Within the city, marked differences are also to be noted: the median sale price of old apartments ranges from € 1,460 / m² in Villeneuve-Village Olympique (less than in Fontaine) to around € 2,700 / m² for the Europole and city centre districts (CCAS, 2019, Notaires, 2020, Notaires, 2019).

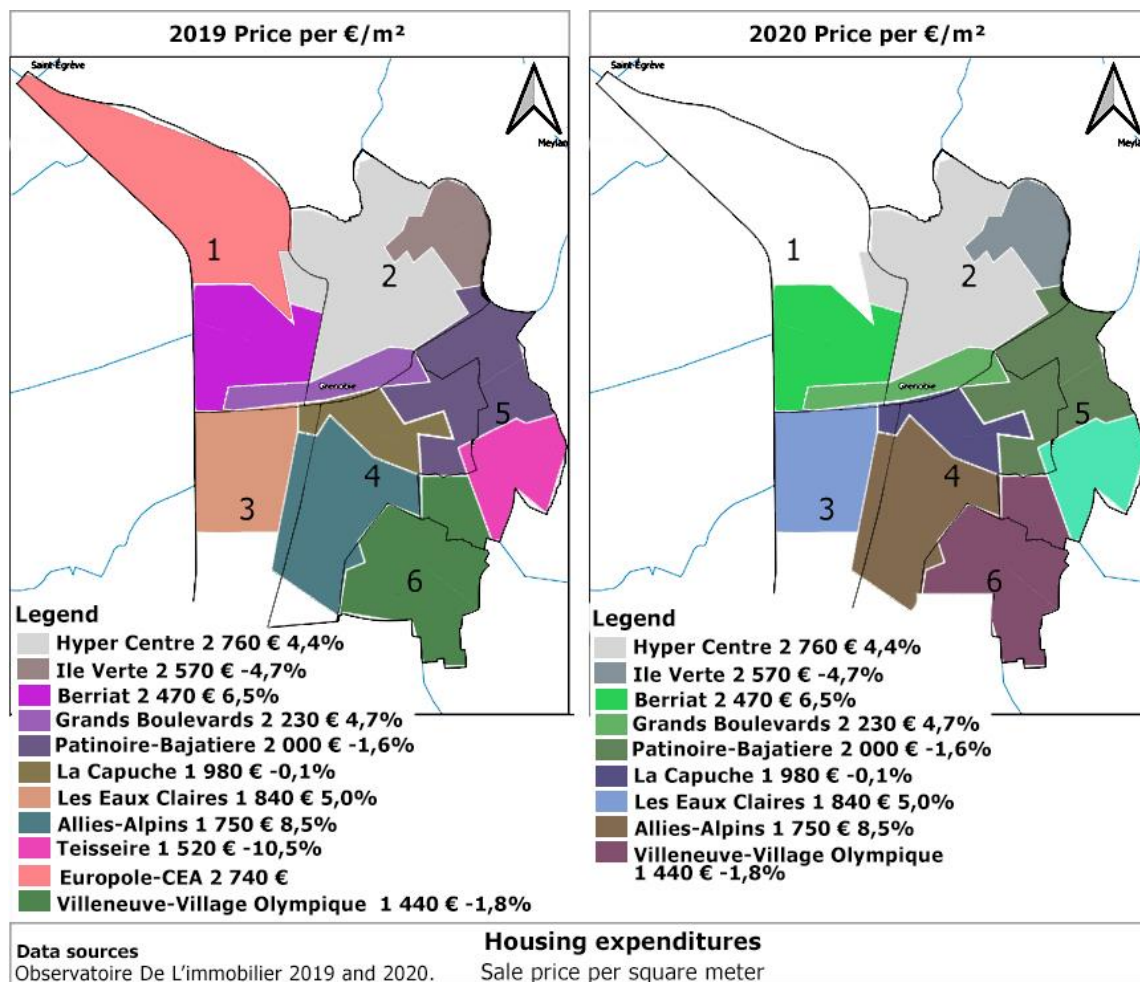


Figure 31. Sale price per square meter, source: CCAS,2019 and Notaires,2019-2020.

Housing provisions

Housing stock – all types

With an average annual growth of 1.7%, Grenoble possess one of the highest housing stocks at the department level (CCAS, 2019). In 2018 the total housing stock reached 98 985 units (INSEE,2018). By analysing the data from the QGIS-Openstreet database and through adding the total number of units completed at the end of 2019, the total stock increased to reach 99 113 completed units, the same method used to estimate the total stock at the end of June 2021 where the total completed unites count reached 99 150 units (Figure 32).

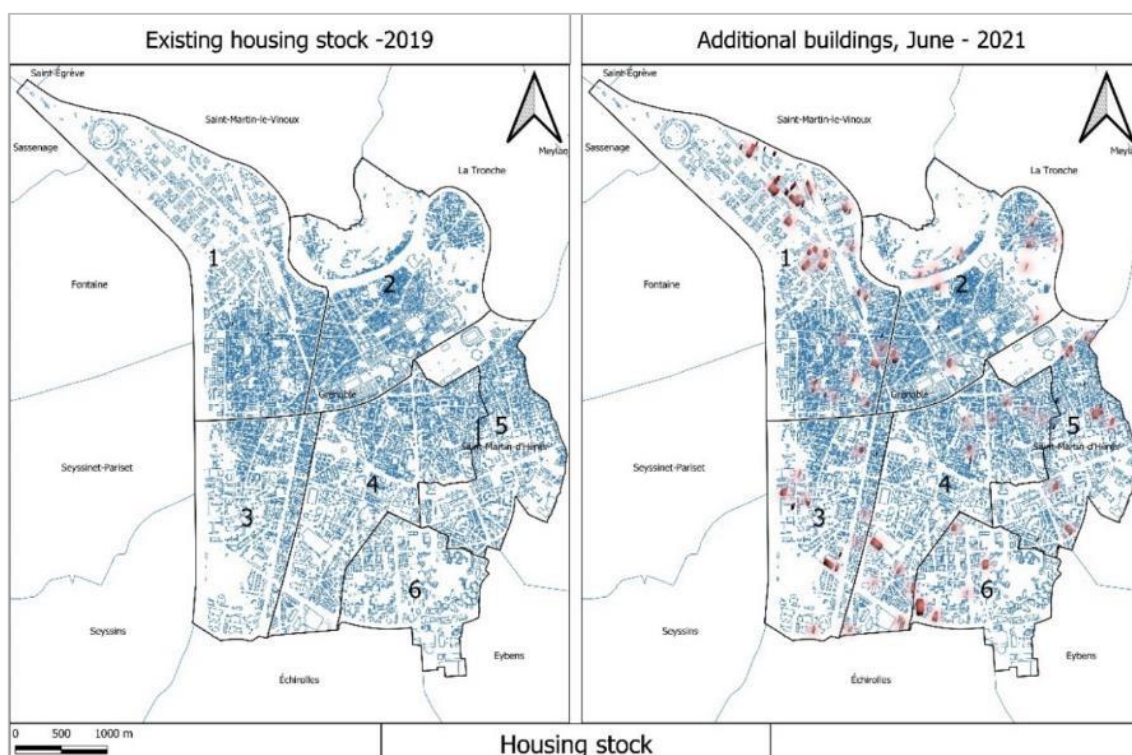


Figure 32. Housing stock location comparison, source: CCAS, 2018, INSEE, 2019, QGIS, 2021.

According to CCAS, 36% of all housing could be classified as either T1 or T2; 23.4% were social housing that was distributed in various sectors of Grenoble. The remaining types of housing made up 59% of the total stock. (CCAS, 2019)

Housing stock – social housing

As of 1 January 2018, Grenoble had 19,908 units of social housing, including 13,736 family units, 4,439 subsidized units in the private sector, and 1,733 hostels (CCAS, 2019, Arnold, 2019). This social housing stock corresponds to 23.4% of main residences in Grenoble (compared to 22% in 2015). This means that Grenoble is still 1,343 homes short of the 25% required by the Duflot law.

In the metropolis, only five municipalities exceeded this quota: Saint-Martin-le-Vinoux, Fontaine, Le Pont-de-Claix, Échirolles, and Saint-Martin-d'Hères (by more than 40% in the last two cases) (Figure 33). Social housing is particularly concentrated in the heart of the metropole; together with Grenoble, these municipalities account for 80% of the entire social housing stock of the area (GAM, 2017, PHS, 2020).

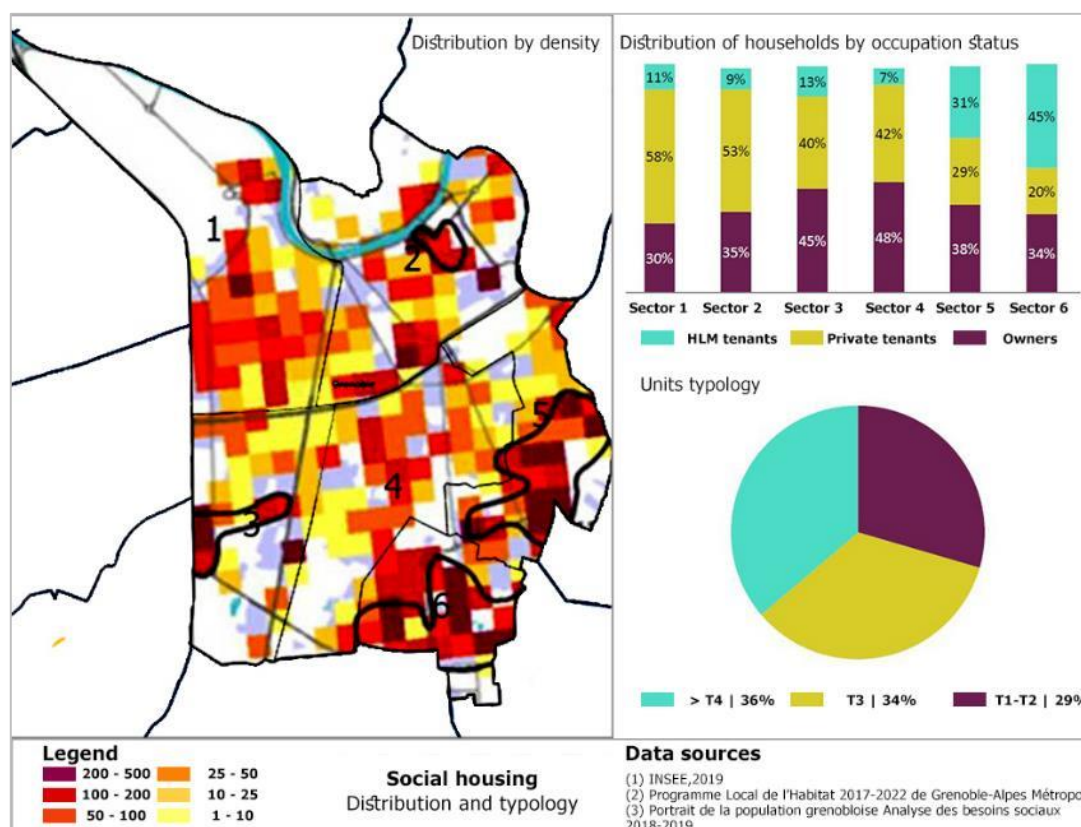


Figure 33. Social housing stock, typology and distribution, source: GAM,2017, CCAS,2018 and INSEE,2019.

Total planned and under-construction housing units

There are two main categories of housing currently under construction, new building and major rehabilitations (requiring extensive maintenance or changing the use of an older building). In 2019, the total amount of construction was significantly less than during the years immediately before and after. In fact, the highest percentage of construction began in Q3 of 2020 and continued into Q3 of 2021 (QGIS, 2021).

This investigation also took into account those building permits that were still in the process of being approved, as these reflect planned construction. In 2020 and 2021, the total number of applications needing approval, whether for new construction or for renovations, reached 40; almost half of these were started in 2019. At the same time, several projects that began in 2018 were stopped or delayed due to administrative complications (Figure 34).

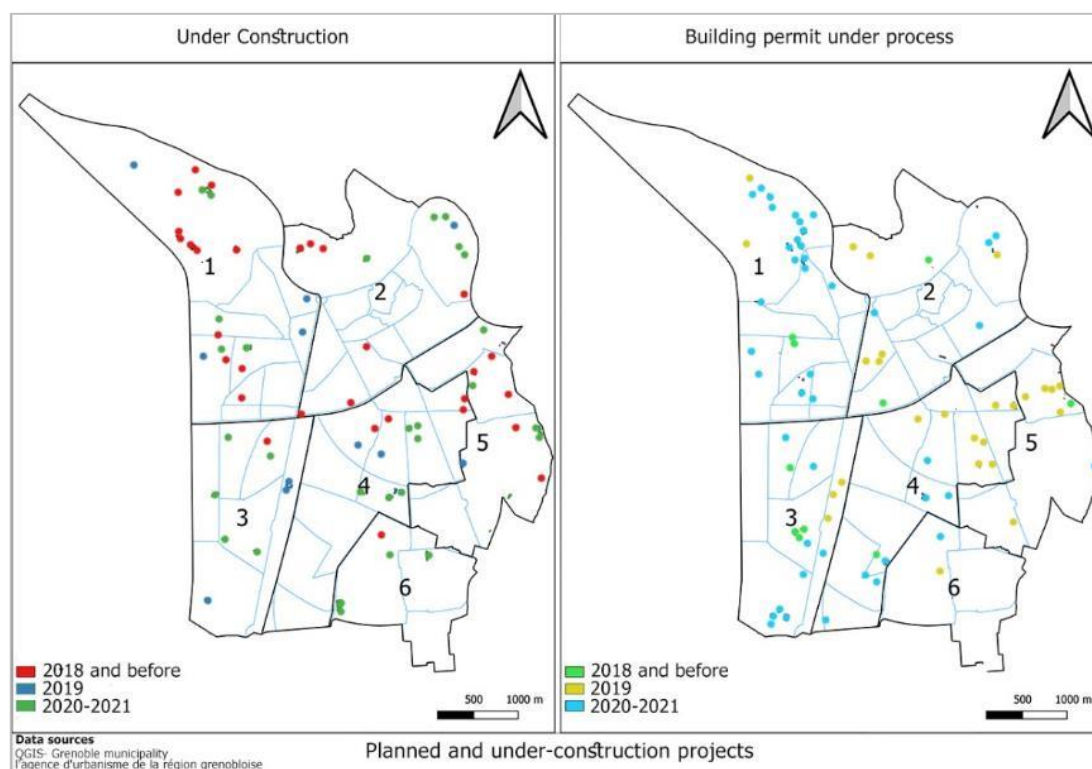


Figure 34. Planned and under construction projects (new, major rehabilitation, major maintenance), source: QGIS,2021

Total units required by applicants

Managing the demand for social housing is the responsibility of the *Pôle habitat social* (PHS), a government agency that supports the municipality of Grenoble. In 2020 a total of 4,967 applications were submitted and 1,139 applications were interviewed and began the process to receive housing. The waiting list in 2020 has reached 6430 applications (Figure 35).



Figure 35. total demand of social housing in 2020, source: PHS,2021.

CHAPTER 4: RESULTS AND DISCUSSION

This chapter presents the thesis findings related to the subjects of pandemics, housing affordability indexes, and the measurement methods of these impacts, which are associated with analysing the qualitative and quantitative data explored in previous chapters. The overall structure of this chapter is divided into two sections as qualitative and quantitative findings; each is divided into subsections relate to the overall methodology of this thesis as explained in chapter 2 (Figure 36).

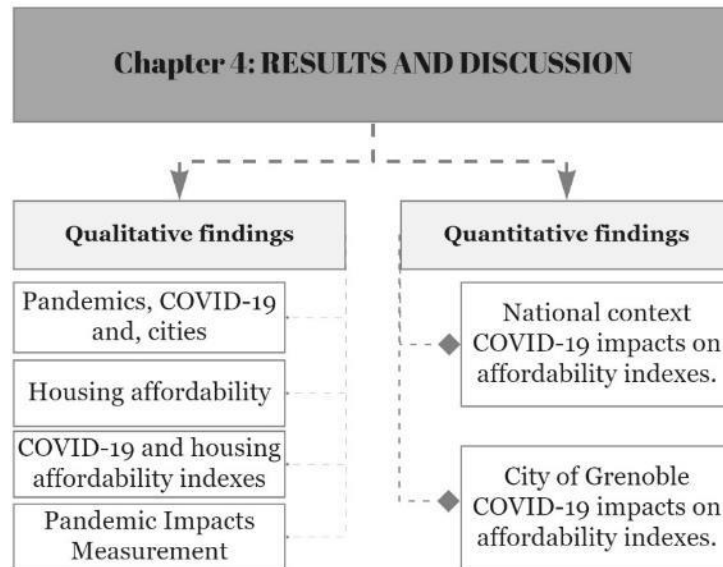


Figure 36. Chapter 4 structure, source: author, 2021.

4.1 Qualitative findings

By revisiting the previous chapters and focusing the research effort into creating a clear review of the findings, this section follows the same structure of the state of art – section 1.3 through 1.3.1 and 1.3.2.

4.1.1 Pandemics, COVID-19 and, cities.

The debate of COVID-19 impacts is still arising, with two sides. The first see the negative impacts of COVID-19, which infested clearly in the economy, health, socially and politically. Another side sees the current pandemic as an opportunity to rethink our cities and fix the fragile relationships with the environment, focusing on what we have achieved environmentally (emissions reduction) and reminding countries what can be achieved without destructing our environment.

Although COVID-19 is not the first pandemic in this century, it hit hard and fast, impacting all sides of life. Without a clear response to ease its impacts, most of the first response policies were often temporary, place-blind, and isolated. They were primarily focused on increasing awareness of the virus and changing the behaviour of people to reduce direct contact and, therefore, to reduce the spread of COVID-19 (Development, 2020).

Not long after the first wave of the pandemic, many reports and studies (most notably the publications of UN-habitat's) were published stressing the need to rethink the urban form and to adopt new measures. Most of the studies focused on (1) transportation autonomy, (2) rethinking the blue and green mixture within the urban fabric, (3) decentralizing services and decrease the dependency on core management, (4) support and increase the role and existence of technology to serve cities and humanities (UN, 2020, Sharifi and Khavarian-Garmsir, 2020).

Poverty and inequality were the major themes of post-COVID-19 studies. to face COVID-19, the government must design targeted interventions that mitigate the disproportionate impacts of COVID-19 and related restrictions on poor and vulnerable groups through emergency assistance and service provision while also taking steps to address the underlying causes of their exclusion.

4.1.2 Housing affordability.

Housing affordability, affordable housing, and social housing are different concepts, yet they all reflect similar goals and objectives. Many scholars have agreed that defining housing affordability is conditional and that establishing a universal definition is very complicated (Stephen Ezennia and Hoskara, 2019). In its most basic form, housing affordability simply refers to the mathematical representation of income ratio to spending; more sophisticated housing affordability measures consider (1) how much non-housing expenditures are limited by how much is left after paying for housing, or (2) they distinguish between "purchase affordability" and "income affordability" (Stone, 2006).

Affordable housing is most often referred to as "social housing," or the type of housing that is controlled or managed by an official authority to make it possible for specific type of population, namely those belonging to the "low-income" population, to access housing. But this more accurately describes "affordable housing," or government-subsidized housing for vulnerable or low-income people (Li, 2015). This should be distinguished from "housing affordability," which refers to the general level of housing prices relative to the general level of household or family incomes, usually measured by dividing median home prices by median family incomes.

There has been a long-running but not wholly resolved debate about different approaches to measuring affordability and what standards or norms should be used; the most conventional methods are (1) house price to the income approach, (2) housing expenditure to the income approach, (3) residual income approach, (4) housing supply measure approach. Aside from these four major approaches, scholars argue extend to include other approaches such as the "behavioural approach" and the "subjective approach," which seen as multi-criteria methods, the Gini coefficient, and mobility probability plot.

An investigation of these indexes allows us to formulate a broad definition of housing affordability indexes adopted in most European countries, despite the outward differences in their definitions or the terminologies they used. The most used indexes to assess housing affordability are (1) household income, (2) household expenditure (cost of living without rent), (3) Housing expenditure -

rent or sale prices, (4) housing provisions, (5) categorization indexes such as Type of population targeted (low-income, middle-income) and the Geographical location and city capacity.

There is a general agreement among scholars that COVID-19 has both directly and indirectly impacted housing affordability. To understand these effects, one must begin by investigating the indexes associated with them, including household income, expenditures (non-housing and housing-related), housing provisions (housing stock and demands). Additionally, one must also carefully consider other variables such as geolocation and each city's characteristics.

4.1.3 COVID-19 and housing affordability indexes.

Measuring the impact of a pandemic can be a difficult and expensive process (Ejiogu et al., 2020). Like any other scientific process, measuring an impact requires systematic, clear, and objective steps that determine and clarify the method and objectives underpinning the measurement. It starts by (1) Identify the subject and objectives of the measurement, (2) establishing the intention of the measurement, (3) identify the intended outcomes, (4) investigate and identify the indicators of the investigated subject, (5) analyse the data and organize it in the form of outcomes.

Although many scholars, organizations, and agencies have already established frameworks and methods for measuring the affordability of housing, these are insufficient in two main areas. First, these methods focus on specific characteristics, which are often driven by economic reasoning such as income, expenditures, or market value. Second, none of these methods (as explored in section 1.3.13 and 1.3.2.2) see the pandemic as a variable to be considered in the planning and measuring of housing affordability in long or short term.

The impacts of COVID-19 were observable on many levels, only some of these were clear and easy to pinpoint, such as COVID-19's effect on health and the economy. Other effects did not surface immediately, like those on mental health and wellbeing, but perhaps had deeper impact on cities and society more generally (Kang et al., 2020). The responses to these effects, as well as the methods to assess these effects, varied according to location and each authority's priorities (Kang et al., 2020).

Classified as direct and indirect impacts and stretching from housing conditions to overcrowding and homelessness, COVID-19 has affected all sectors related to housing the effects were amplified and surfaced through the followings (1) household income, (2) household expenditures (renters and landlords), (3) housing provisions (construction and planned programs), (4) impacts on social housing, (5) health, and overcrowding, (6) increased risks at shared accommodations, (6) increase Homelessness, vulnerability, and COVID-19 cases (Figure 40) (Pittini, 2019, Hilditch, 2020, Kachanoff et al., 2021).

4.1.4 Pandemic Impacts Measurement Framework (PIM).

The term "framework" is vast by its definition; it aims to explain and support a process or a concept or prove a hypothesis (Godfrey, 2019). It is necessary to create a comprehensive and universal

framework that sees affordability from a different point of view; it should be understood as a transdisciplinary concept, drawing from economics, social sciences, and urban planning. This is essential for improving the responses of cities and societies to pandemics, whether the existing COVID-19 pandemic or future ones

This framework is used to comprehend the meaning of pandemics, the many ways for assessing their impact, the methods for determining affordability, and the various indexes that manage and establish affordability indicators. In doing so, this framework requires identifying all affordability indexes impacted by COVID-19, as identified in section 1.3.2.2, and then measuring the increase or decrease of affordability indicators at a specific location in association with official economic, social, and planning statistics

PIM uses pre-post comparative analyses to measure the impact of a pandemic. At several levels, this framework uses a mixed approach, merging both counterfactual analyses and borderless analyses, as described in section 1.3.1.3. These types of analyses were selected because of their suitability for carrying out pre-post data analysis and their capacity for including uncontrolled variables such as time and location. The proposed framework comprises two main components, each serving a specific purpose (Figure 13), (1) pre-and post-pandemic quantitative input data, (2) pre- and post-pandemic qualitative input data.

4.2 Quantitative findings

4.2.1 National context, the French republic & COVID-19.

Three mandatory lockdowns, and several social distancing measures, were taken to face the complication of COVID-19. Yet, as of 30 June 2021, France has listed 5,772,844 cases of novel coronavirus. Furthermore, 111,057 people have succumbed to the disease as of the same date (Worldometers, 2021). Identifying the impact of the pandemic on affordability indexes is tricky; it requires focusing on the data and indexes identified earlier, which are part of several interconnected statistics.

Household income

Earned fixed income shrunk by -4.9% per cent in 2020 (salaries, compensation, ... etc.), mostly because of job losses and reduced working hours caused by absences for sick leave and childcare; comparing the total losses in income to 2019, the percentage reaches a -0.2, the fluctuation in income reaches its worst decrease in Q1 and Q2 of 2020 – during the first and second lockdowns.

In parallel, social aid (including health and housing) increased significantly, especially on Q1 at 2.3% per cent, and Q2 at 7.9% per cent of 2020, a total increment in 2020 reached +6.5% per cent. Not long after the decrease in Q1, and Q2 of 2020, the economy and total income start to pick up again, and a notable increase in income was recorded as total national income.

Non-housing expenditures

Even before COVID-19, the expenditures ratio was increasing rapidly compared to the national benchmark of 2015; however, its most increment was recorded in Q1 of 2020 at 1.2% per cent increasing. The cost of services and goods started to decline rapidly at the beginning of Q2 of 2020, and for the first time in the past five years, it stabilized at 0% growth (from 2015 benchmark) in Q4 of 2020.

This stabilization changed again in Q1 of 2021, where the prices of goods and services started to increase rapidly as of July 2021; price fluctuation recorded total growth at 1.4% per cent. The increment was justified by the increasing demand, supply shortage and, disruption of the supply chain from foreign countries.

Housing expenditures

All indicators of housing expenditures were increasing compared to previous years. Q2 of 2019 recorded 0.1% from 2015 (as the benchmark of 0%), the same quarter in 2020 recorded 1.6% per cent growth. The Q4 of 2020 recorded the highest percentage at 1.9% increasing in housing rent and 1.4% per cent in housing sale price.

The reasons behind the rapid growth of prices are explained by the increasing demand – where the purchasing power increased as explained by INSEE through the increasing awareness among people about saving and short-term investment.

Housing provisions

Housing stock – all types

Steady growth in housing stock is observable in metropolitan France. According to INSEE, housing stock recorded an average growth of 2.1% per year between 2018 and 2020. Moreover, 37 million housing units were available in 2021, compared to 36.6 million units in 2019. Bearing in mind most of the housing project started before the pandemic and despite the disruption in delivery time, yet it was delivered in 2020 and 2021.

Housing stock – social housing

Although there is no available data for the total stock of social housing in 2020 yet is observable through the data from 2016 to 2019, the social housing stock is declining rapidly. Additional 56,026 new units in 2016, which shrunk to 42,030 in 2019. The prediction of 2020 suggests an increasing stock of social housing mostly because of the successful delivery of 95,000 new units across the French metropolitans.

Total planned and under-construction housing units

According to The Social Union for Housing (*L'Union sociale pour l'habitat - USH*), a shortage of 15,000 unites is expected in 2020, where the initial planned numbers are 110,000 and only 95,000 were delivered at the end of 2019.

To conclude, while household incomes have decreased and both non-housing and housing expenditures have increased, government subsidies have increased significantly. The housing stock in general has also increased, although there is no data yet for the amount of housing that was planned for or constructed during 2020. The actual impact of the pandemic on housing construction will become clearer during the next few years, especially since the construction of some projects started before the COVID-19 crisis. The table below presents all the indexes for housing affordability for the years 2019 and 2020 (table 12).

Table 12. French Republic affordability indexes review 2019,2020, source: author,2021.

Index	2019	2020	Effects
Household income – fixed	+3.1%	-0.2%	Decrease in the total income of a household at the national scale because of reduction in the working force, working hours, and increased absences due to sickness.
Household income - social aid	+0.3%	+6.5%	Increase in social aid including subsidies, cash support, tax relief, and health aid
Non-housing expenditures	+1.2%	+0.1%	Decrease in the price of goods and services, according to the median average of 2020, yet

			the fluctuation between Q1 and Q4 of 2020 is notable.
Housing expenditures – Rent	+0.1%	+1.9%	Rapid increase in housing rent, the index (0%) being the national benchmark of 2015
Housing expenditures – sale price	+0.6%	+1.4%	Increase in real house price compared to the national benchmark of 2015
Housing stock – all types	36.6 million units available	37 million units available	Average growth of 2.1% per year between 2018 and 2020
Housing stock – social housing	-1.3%	No data available	The prediction of 2020 suggests an increasing stock of social housing mostly because of the successful delivery of 95,000 new units across French metropolises.
Housing stock – planned and under-construction housing	+ 95,000 units	No data available	A shortage of 15,000 units is expected in 2020

4.2.2 The City of Grenoble & COVID-19.

Grenoble is one of the most populous cities in France, with an approximate population of 154,000 and a density of 8,868 inhabitants/km². The city is divided into six sectors that have different land uses and that vary in size: sector 1 is 3.7 km²; sector 2 is 4.7 km²; sector 3 is 2.6 km²; sector 4 is 2.3 km²; sector 5 is 1.7 km²; and sector 6 is 3.2 km².

COVID-19 has affected Grenoble much like it has affected other cities, causing a complete lockdown, reviews, commercial closures, and movement limitations. The city also witnessed the second highest recorded number of cases of COVID-19 in the department, trailing only behind Lyon. The data reviewed suggest that the pandemic's overall impact on housing in Grenoble, however, was slightly less acute than elsewhere in the country. Still, the effects were notable, as revealed by the indexes investigated here.

Household income

As of 2018, the average annual disposable income in Grenoble was slightly over € 20,000, or about € 1,700 per month. The highest average income was recorded in sectors 1 and 2 (in and around the city centre), where it reached € 24,799 per year. This is likely due to the higher employment rate there as well as the concentration of national and international companies.

The lowest annual income, less than € 15,300, was observed in sector 6 and parts of sectors 3 and 4, all of which have high unemployment rates. Although there are currently no data for 2021, simulations suggest that incomes will increase due to a growth in entrepreneurship and the number of small businesses there, as well as the completion of several development projects that had begun before the pandemic; these simulations suggest that sectors 4 and 5 possess the highest potential for growth.

Non-housing expenditures

There was an exceptional increase in prices of goods and services in Q1 and Q2 of 2020, as compared to the same period in 2019. A 1.5% increase in cost was observable, yet that percentage dropped radically in Q3 and Q4 of the same year. At its lowest, during Q3 of 2020, the percentage of growth was 0%, based on a 2015 index, which was 2.5% lower than in 2018.

Housing expenditures

In 2018, rents in the Grenoble metropole ranged from an average of € 10.6 / m² to € 12 / m², the highest rents being recorded in sectors 1 and 2, and the lowest being recorded in sectors 3, 4, 5, and 6. In 2019, rents increased by an average of € 0.1 except in the city centre, where rents fell by the same amount, reaching an average of € 11.9 € / m². The prices in sectors 5, 4, 3 and 6 increased to an average of 10.6 € / m².

Likewise, the average price of houses increased between 2019 and 2020, although the average price of old homes in Grenoble has been declining since 2012. According to the Observatory of Rent, the median price of an apartment in an old building in Grenoble was € 2.130 / m². Meanwhile, the median price of a new house was € 3.920 / m². It is notable, however, that among old apartments, half

of them sold for an average price of € 1.510 / m² in Fontaine and € 1.870 / m² in Saint-Martin-D'Hères. There are also marked differences in pricing within the city worth noting: the median sale price of old apartments ranges from € 1.460 / m² in Villeneuve-Village Olympique (less than in Fontaine) to around € 2.700 / m² in the Europole and city centre districts.

Housing provisions

Housing stock – all types

In 2018 the total housing stock reached 98,985 units. Growth was steady during 2019, as another 128 houses were added to the stock, resulting in a total of 99,113 units. However, COVID-19 and construction restrictions have resulted in fewer houses being completed in 2021. Only 37 units were added by June 2021, making the total 99,150 units. The highest concentration of new projects was in sectors 1 and 4, followed by sectors 2, 4, 5 and 6.

Housing stock – social housing

According to CCAS, 23.4% of the total housing stock in Grenoble is social housing (compared to 22% in 2015). More specifically, as of 1 January 2018, Grenoble had 19,908 social housing units, including 13,736 family units, 4,439 subsidized units in the private sector, and 1,733 hostels.

Table 13 compares the typology of housing in each sector. The highest percentage of social housing is recorded in sectors 5 and 6, which, as we have seen, also have the lowest average income per household. The lowest percentage of social housing is recorded in sectors 2 and 4, mainly due to the limited housing stock in these sectors. Meanwhile, sectors 1 and 3, which have the highest average incomes per household in Grenoble, have 11% and 13% social housing respectively.

Table 13. Grenoble housing typology by sector, source: CCAS,2020, QGIS,2021.

Type	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6
Social housing – HLM	11%	9%	13%	7%	31%	45%
Private tenants	59%	53%	40%	42%	29%	20%
Owners	30%	35%	45%	48%	38%	34%

Total planned and under-construction housing units

To measure the impact of COVID-19 on the planning and construction of housing, this study has reviewed two sets of data: the total number of housing projects under construction in 2019, and the total number under construction in 2020 and 2021. Notably, all construction activities were halted in Q1 of 2020, and the highest percentage of activities was recorded in Q3 of 2020. In Grenoble, sectors 1 and 4 saw the most construction activities, largely due to development projects, the vacancy of the land, and the high income of these sectors.

Moreover, far fewer building permits were issued in 2021 than in 2018 and earlier. There were also fewer applications received. By Q3 2021, the total number of applications, whether for new

buildings, major rehabilitations, or major maintenance projects, was less than 40, less than a third of the number received in 2018 and the years before then.

Total units required by applicants

According to the Social Housing Unit (*Pôle habitat social* (PHS)), a total of 4,967 applications were submitted in 2020 while 1,139 applicants were interviewed and began the process of receiving housing. The waiting list in 2020 reached 6,430 applications.

To conclude, based on a review of the previous data, Grenoble has suffered many of the same setbacks from the pandemic that other cities have faced. The side effects did not appear in all affordability indexes, but they were obvious in some of them. Table 14 reviews all the indexes together, clearly showing the effect that the pandemic has had on each.

Table 14. Grenoble affordability indexes review 2019,2020, source: author,2021.

Index	2019	2020	Effects
Household income – fixed	1,700 € average	No data available	Projections suggest that income will increase slightly, especially in the sectors where the income is the lowest (sectors 4 and 6).
Household income - social aid	No data available	No data available	Official statistics for social aid by commune are not available. However, most of the data reviewed indicates an average increase in social aid approximately by 5.5%, as compared to 2015.
Non-housing expenditures	+1.9%	-1.1%	Decrease in the price of goods and services, compared to the median averages of 2018 and 2019.
Housing expenditures – Rent	+0.1%	+0.1% -0.1%	A fluctuation of +/- 0.1% is notable and reflects changes in different sectors. Sector 1 has the highest expenditures, and sector 2 has the lowest.
Housing expenditures – sale price	+0.6%	+1.1%	Whether there was an increase or a decrease in housing expenditures depends on which sector one looks at. The largest increase was in sector 4, and the largest decrease was in sectors 1 and 2. The average expenditure of 2015 is the benchmark (0%).
Housing stock – all types	99 113 units available	99 150 units available	Very low growth in housing stock (0.01%).

Housing stock – social housing	+2.1%	-0.1%	Shortage of 1,400 units is predicted for 202 by comparing the total number of applications with the total housing stock.
Housing stock – planned and under-construction housing	+ 115 units	+40 units	Sharp drop in the planned housing supply in comparison to 2018 and the years before.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

This chapter seeks to summarise the thesis and its findings and discusses various ways of facing and measuring how pandemics impact housing affordability indexes. Doing so can help close the gap between theoretical methods and actual needs to accurately estimate the impacts and form a comprehensive understanding of pandemic behaviours and consequences. The discussion begins with general conclusions about the subject at hand, then moves to a specific context (Grenoble, France) and discusses all investigated key points from previous chapters.

5.1 Pandemic responses

Our city is facing an increasing risk of pandemic and must be prepared. The behaviour of a pandemic varies according to the location, time and characteristics and uniqueness of each event. Most cities acknowledge the existence of potential negative impacts from the pandemic, yet there are no unified guidelines for such cases. The existing guidelines use principles prepared from a medical point of view and leave out the actual needs of the city's inhabitants from urban planning and design approaches, such as wellbeing, mental health and source of income.

COVID-19 offers a perfect example of the unpreparedness of our communities against emerging challenges. Our cities depend on intangible systems such as economics and trade. Yet tangible systems such as the environment, transportation, health and communications command most of the attention during urban planning and design. At the same time, COVID-19 demonstrated to governance bodies what could be achieved with minimal resources, especially in terms of environmental protection and climate challenges.

Although many scholars and policymakers argue that our responses against COVID-19 were successful in saving thousands of lives, the actual impacts of these policies will continue to affect human lives for many years to come. Responses against pandemics must be flexible, considerable and look to cities as an entire system that must be protected, with or without a pandemic. Different urban forms and planning factors can influence how COVID-19 will impact cities and their inhabitants' lives; consequently, planning for resilience is vital to facing future similar pandemics; therefore, planning for a better future must start by defining what is necessary and complementary in our societies.

The French Republic and the city of Grenoble have suffered the same consequences from COVID-19 as all other countries and cities, yet their responses were more effective in focusing on the human factor. The need to protect human life outweighed the risk of economic loss, which translated into several mandatory lockdowns. At the same time, social aid played a major role in the responses; the notably increased government subsidies were open to all inhabitants, regardless of their condition or priority.

The government policies adopted at the beginning of the crisis have rapidly shifted from medical attention only to include social and psychological support, not only in abstract ways but also by facing

and reducing the anxiety and stress generated by the lockdowns and economic decline; indeed, most of the subsidies and support focused on direct and fast intervention to enhance inhabitants' wellbeing, regardless the economic expenditures.

5.2 Pandemic impacts

COVID-19 impacts have stretched from the economic, political, social and physiological to the environmental. The effects ranged from extreme to normal to nonimportant. The economy has manifested the most notable type of impact, with a total loss in the international economy reaching 4.6% of the world's total GDP; at the same time, a notable portion of cities' populations were significantly affected socially and psychologically by increased poverty, lack of shelter, homelessness, and increased violence. Several reports published by the UN and OECD showed that COVID-19 has widened the gap between societies and led to increased untargeted discrimination for low income and vulnerable groups.

Measuring the impacts of COVID-19 is a very complicated task that requires a considerable amount of data, effort, and systematic analysis. The current method of measuring COVID-19's impacts focus on direct and tangible impacts, such as economic losses, death and infectious cases, yet measuring its indirect impacts is vital to the successful creation of policies that mitigate the negativity of externalities and help rapidly maintain cities' and inhabitants' wellbeing.

There are no clear statistics or studies on the hidden cost of the pandemic on the national scale, although there are a great number of reports and studies that indicate the importance of investigating the long-term effects of the pandemic, yet achieving this view requires a high level of collaboration and coordination among all services sectors, which at the moment is difficult to achieve, especially with the varying responsibilities and priorities of each sector.

5.3 Housing affordability.

Creating a universal definition of housing affordability requires a high level of coordination and investigation on regional and international scales. Housing affordability is a transdisciplinary concept that depends on several indexes that must be viewed seen together. Housing affordability is more than the cost of living compared to the cost of housing or the percentage of spending: Housing affordability is a set of interlinked concepts that start from the wellbeing of inhabitants and economic conditions and stretch to policymaking and city-planning.

Housing affordability is most often referred to as "social housing," or housing that is controlled or managed by an official authority to make it possible for a specific part of the population, namely "low-income" residents, to access it. But this definition more accurately describes "affordable housing," or government-subsidised housing for vulnerable or low-income people. This term should be distinguished from "housing affordability," which refers to the general level of housing prices relative to the general level of household or family incomes, usually measured by dividing median home prices by median family incomes.

While investigating housing affordability, several important acronyms emerged. Studying housing affordability requires also exploring these acronyms. Studying housing affordability requires a deep investigation, yet defining the related indexes is a complicated task. Whereas direct indexes are obvious and easily monitored, other indirect indexes are harder to pinpoint and study. Affordability indexes can be sorted into economic categories – income, expenditures, urban and planning, including housing provisions and planning for housing – and social categories that study and measure inhabitants' social engagement and wellbeing. All these categories are equally important and must be studied together.

There are several approaches to assess and measure housing affordability, such as the house-price-to-income approach, housing-expenditures-to-income approach, residual-income approach and housing-supply-measure approach. Yet each approach focuses on a specific type of indicator. Therefore, each approach is suitable for specific conditions, and each has applicability limitations. Therefore, there is a need to reinvestigate these approaches and bridge the gaps to achieve a higher integration approach that considers and treats affordability as a multi-layer concept.

The French system does not recognise housing affordability as a separate concept, whereas social housing is usually discussed. The French social housing system is one part of a larger social configuration that has operated for many years. Its existence is directly linked to the existence of laws and culture. Social aids are a deeply rooted principle in French city-planning. Despite efforts toward increasing the support of social aid, there is a notable decline in its component over the last couple of years, mostly due to economic challenges, the population boom, and the limitations of city capacities.

5.4 COVID-19 and housing affordability indexes

COVID-19's impacts on housing affordability indexes in the French Republic were notable. France saw a rapid decrease in income followed by a rapid increase in the price of goods and services, especially at the beginning of the pandemic. Yet these impacts were mitigated rapidly and eased by governmental intervention that mainly focused on increasing aid for vulnerable groups and then to every inhabitant. The total economic losses caused for individuals were covered by government subsidies.

Despite the clear effort to cover and cope with COVID-19's impacts, several negative effects manifested, such as the temporary surcharge on rent prices and operational housing costs. However, it is difficult to distinguish between typical market growth and the temporary increase caused by COVID-19. Yet the same pre-COVID-19 policies are still in place, prompting a hypothesis that there is a gap in policies to ease the impacts on housing indexes related to income and expenditures.

Housing construction was one of the most affected fields. However, many housing units were delivered in 2020 and 2021, yet they did not meet housing demands and the pre-planned housing program agenda. This shortage will reappear in the future if no immediate action is taken to cover this shortage.

Grenoble is one of the most populated cities in France, with one of the highest social housing percentages, yet a rapid increase in demand for social housing was present at the end of 2020. The unequal distribution of social housing in each sector makes it difficult to integrate social housing units on a city-wide scale. The current focus of social housing is in sectors 4, 5 and 6, where the poorest groups and the highest unemployment rate is present. With these facts, the effort to build more housing units in these sectors is still inadequate. Therefore, the housing crisis is expected to amplify in upcoming years.

The impacts of COVID-19 on Grenoble's sectors varied from highly observable, such as in sectors 4 and 6, to usual impacts level, such as in sectors 1 and 2, although the high percentage of business lockdowns and the total economic conditions did not change dangerously often because of the high percentage of governmental aid at the national level.

5.5 Research questions review.

To conclude the discussion for this thesis, it is important to revisit the research questions for clearer answers. There are several affordability indexes directly related to COVID-19, especially the indexes linked to the economic, social and urban planning categories. The direct impacts of COVID-19 on housing affordability were notable in the indexes of household income, non-housing expenditures, housing expenditures and housing provisions, including housing stock and demand.

To measure the impacts of COVID-19, it is first important to set the scope of the measurement, identify the indexes related to the intended measurement type and then investigate household composition, income, expenditures, the geospatial characteristics of housing provisions and social links to the inhabitants and the allocation of housing. COVID-19 demonstrated that our system needs constant updating to cope with various needs. The pandemic affected intangible aspects of the city system at the same level as it did tangible systems; therefore, planning for resiliency for future pandemics is important and vital.

Developing a suite of tailored economic support and relief packages can help smaller businesses, informal workers and at-risk sectors survive the crisis, with an emphasis on "building back better" by promoting the transition to greener, more equitable urban economies. Urban morphologies and systems must be reconfigured at different scales to enhance their resilience to the effects of a pandemic and make them more sustainable and productive in the long term through inclusive planning.

Targeted interventions should be designed to mitigate the disproportionate impacts of COVID-19 and related restrictions on poor and vulnerable groups through emergency assistance and service provision while also taking steps to address the underlying causes of their exclusion. There is a need for more integrated, cooperative multi-level governance among national, regional and municipal governments that focus on developing more flexible and innovative institutional and financial frameworks through which cities can effectively respond to the unfolding crisis.

5.6 Limitations and future development

This research offers many opportunities for developing more comprehensive and accurate policies should more resources become available. While developing this research, however, several limitations were discovered that reduced its scope and hindered its aims.

- *Data availability:* This research is highly dependent on data availability, especially economic reports and statistics. The absence of these data, namely in countries where economic statistics are not periodically produced, can therefore pose a serious challenge.
- *Interpretation of data:* Several agencies and authorities produce the same sets of data, yet in some cases, the scope of the data and the results differ from one publisher to another, reflecting the different motives that underpin each data set. Therefore, the selection and interpretation of data must follow the framework's original scope when measuring the impact of pandemics.
- *Time as a changing variable:* Time strongly influences affordability, and the affordability index is directly linked to economic stability; therefore, the time set for an analysis must be clear and align with the data.
- *Resource availability:* Although the framework is simple, it requires considerable human work; therefore, the absence of a practitioner-researcher or data analysts might present a challenge, especially in analysing complicated cases.
- *Pandemic characteristics:* Every pandemic possess different characteristics. Some pandemics impact the economy more than they do societal wellbeing, and vice versa. Therefore, understanding the behaviour and impact indexes is important and must be clarified before adopting this framework.

Future development. As proposed here, the PIM framework requires several manual procedures that includes the collection and analysis of data. The framework may be enhanced, however, through the following means.

- *Further studies:* Several important aspects of housing affordability were not included in this study, such as the role of social indexes and human wellbeing, living conditions and housing design principles; therefore, this study should be expanded to include such aspects' influence on housing affordability and their relation to pandemics.
- *Artificial intelligence:* All the processes can be converted into logarithmic languages, leading to increased accuracy, and reducing the effort required to generate a result.
- *Cloud sharing – platforms:* Repeated use of the framework could highlight areas that could be improved and thus may increase its accuracy. Also, cloud sharing could lead to a universal approach to understanding affordability and the effect of pandemics by using similar indexes in different locations. At the same time, the existence of an accessible and easy platform would allow local authorities and agencies to conduct analyses without limitations or delay (Figure 37).

- *Computing tools*: Spreadsheets are often used to assess impacts, and spreadsheets possess the ability to encode requirements and formulas in easy and editable steps.

PIM
Pandemics Impacts Measurement platform

PIM Technology PIM Indexes Index Services Governance Contact Us Login

Progress: Project Information Pandemic Information **Affordability data** Analysis process Results

Previous **Affordability data** NEXT

Please, fill in all data of housing affordability indexes as indicated in tabs below

Household income	Non housing expenditures	Housing expenditures	Housing provisions
Fixed income per household Total Unit Time	Fixed expenditure per household Total Unit Time	Cost of rent (per m2) Total Unit Time	Total available unites Total Unit Time
Other income per household Total Unit Time	Temporary expenditure Total Unit Time	Cost of utilities Total Unit Time	Total planned Total Unit Time
			Total unites required Total Unit Time

Data sources

Eurostat Worldbank OECD
ECRI EU-SILC AMECO
INSEE QGIS OSM

Location

Figure 37. PIM proposed online platform, source: author, 2021

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APPENDIX

During the investigation of the literature, this thesis revealed several important and interlinked subjects. However, due to the limitation of time and relevancy purposes, this section has been created to include relevant information that has not been used in the investigation and development of this thesis, which might help in further studies in the future.

Appendix A, Impacts Definitions

Impacts definition proposed by different agencies, and organizations, source: as indicated in definition column.

Table 15. Impacts definitions by various organization, source: as indicated in definition column.

Organization/ agency/ policy / framework	Definition
United Nations	“Defining the term impact implies changes in people’s lives. This might include changes in knowledge, skill, behaviour, health or living conditions for children, adults, families, or communities. Such changes are positive or negative long-term effects on identifiable population groups produced by a development intervention, directly or indirectly, intended, or unintended. These effects can be economic, socio-cultural, institutional, environmental, technological or of other types. Positive impacts should have some relationship to the Millennium Development Goals (MDGs), internationally-agreed development goals, national development goals (as well as human rights as enshrined in constitutions), and national commitments to international conventions and treaties.” (Bester, 2012).
European Commission	“In an impact assessment process, the term impact describes all the changes which are expected to happen due to the implementation and application of a given policy option/intervention. Such impacts may occur over different timescales, affect different actors and be relevant at different scales (local, regional, national and EU). In an evaluation context, impact refers to the changes associated with a particular intervention that occur over the longer term.” (EU, 2018).
Development Co-operation Directorate (OECD-DAC)	“The outputs (actions – either isolated or part of a program) have a core set of goals meant to be fulfilled that end up encompassing multiple side effects.” (Simon Hearn and Buffardi, 2016)
UN SDG’s 2030	“Having positive effects on the economy, the environment, and social wellbeing via the contribution to the UN’s 17 goals until 2030: from ending poverty to protecting life underwater or creating resilient cities. Therefore, actions and programs aiming to have an impact around this area need to be framed regarding how they are

Cambridge dictionary

contributing in favour of social and/or environmental goals.”
(Simon Hearn and Buffardi, 2016)

“a powerful effect that something, especially something new, has
on a situation or person; it also refers to have an influence on
something leading to a change of conditions” (Cambridge, 2021)

Appendix B, Synonymous and associated terminologies with housing affordability.

Table 16. Housing Affordability Synonyms across Different European Countries, source: Rosenfeld, 2017

Country/ agency	Associated terminologies
Germany	Social housing, municipal housing, social rented housing, rental price brakes, housing benefit ¹ , society for building and living. ²
United Kingdom	Social rented, affordable rented and intermediate housing, social assisted housing (Preece et al., 2020).
France	Social housing, Low-income housing ³ , and public (state) housing, subsidized housing, co-operatives housing.
Italy	Social housing, subsidised housing ⁴ , assisted housing ⁵ , agreed housing ⁶ .
Spain	Public housing, state housing.
Ukraine	Social housing, state housing, youth housing
Poland	Social housing ⁷ , municipal housing
Romania	Mortgage-free housing, social housing, controlled housing.
Czech Republic	Municipal owned housing, public supported housing.
Greece	Social housing, social rented housing.
Portugal	Social housing, social rent.
Sweden	Affordable rented housing, social housing, low-income housing, public utility ⁸
Austria	Social housing, non-profit housing, non-repayable subsidies, affordable home ownership
Switzerland	Social housing, municipal housing
Denmark	Affordable rental housing, social housing, cooperative housing.
Finland	Non-profit housing, social housing.
Slovakia	Social housing, state housing, subsidised housing.
Luxembourg	State housing, housing subsidies, state housing gran
Netherlands	Affordable housing, housing subsidies.
Slovenia	Public housing, housing subsidies, state housing allowance
Latvia	Housing for low-income, social apartment.

¹ Wohngeld - translated to housing benefit.

² Gesellschaft für Bauen und Wohnen – translated to society for building and living.

³ Habitation à Loyer Modéré (HLM) – translated to low-income housing .

⁴ Edilizia sovvenzionata – translated to subsidised housing.

⁵ Edilizia agevolata – translated to assisted housing.

⁶ Edilizia convenzionata – translated to agreed housing.

⁷ “Lokale socjalne” and “Lokale społeczne” – translated to social housing.

⁸ Allmännyttig – translated to public utility (social housing is not used as term).

Appendix C, Housing affordability definition by country.

Table 17. Housing affordability definitions, source: as indicated in definition column.

Country, or agency	Authoritative ¹	Definition
Germany	No	“Affordability means the regulation and laws adopted in all federal states, with respect to the uniqueness and singularity of each state. It aims to support those households which would otherwise not be able to find appropriate accommodation on the housing market. These include low-income households and families and other households with children, lone parents, pregnant women, the elderly, the disabled, the homeless, or others in need” (Droste and Knorr-Siedow, 2014).
United Kingdom	Yes	“Affordable housing includes social rented housing, affordable rented housing, and intermediate housing, provided to specified eligible households whose needs are not met by the market. It can be a new-build property or a private sector property that has been purchased for use as an affordable home” (Preece et al., 2020, MHCLG, 2019).
France	No.	“Affordable housing is the term given to accommodations which are provided at affordable rates (calculated based on total income of household), on a secure basis to people with low incomes or with needs (elderly, employee, vulnerable people, etc.). Social housing properties are usually owned by the state, in the form of councils, or by non-profit organisations such as HLM, OPH, ESH, or EPL. ² ” (IBHS, 2018b, Scanlon and Whitehead, 2011)
Italy	No	“Housing which aims to meet the housing demand of those who cannot access the free market, but who are still in a position to sustain a rent with controlled prices or to buy accommodation at a contracted price” (Europe, 2010).

¹ **Authoritative**: a definition clearly identified and used by the authority of the countries under investigation [**Yes**: definition available through laws, **no**: definition not clear or not available, **not applicable**: definition that is created by a non-governmental agency that operate under laws of the investigated country].

² OPH : Offices Publiques de l’Habitat, ESH : Entreprises Sociales pour l’Habitat, EPL : Entreprises Publiques Locale

Poland	No	“Housing that is dedicated to the lowest-income people, ¹ to low-income people who do not have the rights to another residential property, or to middle-income people”. ² (IBHS, 2018a)
Romania	Yes	“Public dwellings with subsidized leases allocated to individuals or families whose financial position would not otherwise allow them access to tenements leased on the market” (Ciora, 2015).
Portugal	No	“A proper house unit with an appropriate size and number of bedrooms for a specific family with a rent not higher than 30% of that family’s income. It can be owned by the municipality or by profit or non-profit organizations with public support or incentives when applicable” (Scanlon et al., 2015).
Sweden	No	“Rental dwellings owned by municipal housing companies that are organized as joint-stock companies. Affordable housing must be provided for everyone regardless of income level” (Scanlon et al., 2015).
Austria	Yes	“Affordable housing is any adequate and reasonably-located housing for lower- or middle-income households and does not cost so much that a household cannot afford other basic needs on a regular basis” (Rosenfeld, 2017).
Slovakia	No	“Presently, no legal definition of affordable housing is provided for in any act or sub-statutory regulation in the Slovak Republic. However, the State Housing Policy Concept to 2020 employs this term on multiple occasions. Conceptually, affordable housing (as perceived by the state) shall be perceived as housing for which the total expense does not exceed approximately 30% of the household’s net disposable income” (Rosenfeld, 2017).
Luxembourg	No	“Housing dedicated to households which fulfil the conditions to receive state housing grants or subsidies (these conditions are related to such things as income and household size). As such, if a house is so expensive that the category of the people getting a state housing grant cannot afford it, that house is not “affordable housing” (Pittini, 2019, Scanlon et al., 2015, Rosenfeld, 2017).

¹ Law of 21 June 2001. on the protection of the rights of tenants, housing resources of municipalities and amending the Civil Code

² Social Housing Act (Law of 26 October 1995. on certain forms of support for housing construction).

Netherlands	Yes	<p>“Housing with a fixed maximum payment based on total household income, household size, and total occupancy. For example, the maximum rent in affordable housing is € 711 a month for incomes up to € 39.874, € 629 a month for households of three or more people with incomes up to € 30.500 a month, and € 567 for one-person households with incomes up to € 22.100” (Scanlon et al., 2015).</p>
Slovenia	No	<p>“Affordability of housing in its broader terms is mainly ensured by public non-profit rental housing (dwellings with administrative rents are given with public tenders) and housing subsidies which are given to socially deprived tenants in such dwellings” (Scanlon et al., 2015).</p>
Latvia	No	<p>“Affordable housing is housing that is available for a reasonable price in relation to a household’s income. Additionally, housing affordability is understood as an index used by banks and real estate companies to estimate the relationship between income, housing price, interest rates for mortgages, and inflation rates” (Rosenfeld, 2017).</p>
AEDES ¹	Not applicable	<p>It is generally accepted that when housing to net income ratios exceed 30-35%, affordability comes under pressure (Rosenfeld, 2017).</p>
Housing Europe ²	Not applicable	<p>“Housing Europe does not promote one definition of “affordable housing.” Rather, Working Groups within the organization approach the notion of “affordable housing” from different perspectives. (1) The Urban Committee focuses on exploring how affordability can be achieved in cities. (2) The Energy Committee looks at the impact of environmental policy and legislation on the cost of the construction of affordable housing, whether in new construction or renovations. (3) The Social Affairs Committee investigates the effects of housing policy and practice on social exclusion. (4) The Economic and Finance Committee addresses the financial mechanisms that enable delivering affordable housing. (5)</p>

¹ AEDES: vereniging van woningcorporaties – translated to The Association of Housing Corporations, Netherlands.

² Housing Europe is the European Federation of Public, Cooperative and Social Housing: established in 1988, it is a network of 46 national and regional federations which together gather about 43,000 public, social and cooperative housing providers in 25 countries. Altogether they manage around 25 million homes.

		<hr/> <p>There is also the Housing Europe Observatory Committee in which all of these perspectives are acknowledged” (Rosenfeld, 2017).</p> <hr/>
OECD ¹	Not applicable	<hr/> <p>“The affordability of housing is the capacity of a country to deliver good quality housing at an accessible price for all. Evidence shows that housing has become less affordable over time in most OECD countries, although governments have different policy options available to make housing more available” (OCED, 2020).</p> <hr/>

¹ The Organization for Economic Co-operation and Development: formed in 1948 as an intergovernmental economic organization with 38 member countries, founded in 1961 to stimulate economic progress and world trade.